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Endangered Species Analysis

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Section 1.0 Introduction

Cronus Chemicals, LLC (Cronus or Facility) has requested a Prevention of Significant Deterioration of Air Quality (PSD) construction permit for the construction of a fertilizer plant located just west of Tuscola, Illinois on US Route 36. Cronus is proposing to construct a Facility that would manufacture nitrogen based fertilizers (i.e., urea and ammonia) using natural gas as a feedstock. The manufacture of urea and ammonia using natural gas is well-established with numerous facilities currently operating worldwide using this technology.

The Facility would be developed to primarily produce urea, which is a solid material that can be readily stored and handled. The Facility would also be able to sell a portion of its annual output as ammonia. This is expected to occur on a seasonal basis, consistent with agricultural demand for ammonia.

The Facility is being developed for a nominal daily production capacity of about 4,880 tons of urea or 2,789 tons of ammonia. The principle emissions units at the Facility would be an ammonia plant, with a reformer furnace and boiler, and a urea plant. The ammonia plant would make the ammonia that would either be further processed in the urea plant or stored for direct sale. The gas-fired reformer furnace and the boiler would directly support the operation of the ammonia plant and, by way of the ammonia plant, provide steam for other operations at the Facility.

Ammonia (NH_3) would be produced in the ammonia plant by combining hydrogen (H_2) and nitrogen (N_2). The hydrogen would be made in the reformer from the natural gas feedstock and water. The nitrogen would be obtained from the atmosphere. To produce urea ($CO[NH_2]2$), the urea plant would combine NH_3 with carbon dioxide (CO_2), which is also produced in the ammonia plant.

Other emission units at the proposed Facility would include a urea granulator to produce solid urea and the subsequent storage and handling of urea product. The Facility would also have two flares to control releases of offgas during startup and malfunction of the ammonia and urea plants, a startup heater for the ammonia plant, a cooling tower, and a safety flare for the ammonia storage tanks, components (i.e., valves, pumps and other equipment with potential for emissions from leaks), roadways, and emergency engines.

When the PSD Permit Application was under review by the Illinois Environmental Protection Agency (IEPA), Cronus was contacted by the United States Environmental Protection Agency (USEPA) and informed that an Endangered Species Analysis (ESA) was required to be completed for this project. Cronus was provided with the draft "Recommended Scope of Analysis for Endangered Species Evaluation" (a.k.a "Roadmap") (Appendix A) by the USEPA. The Roadmap indicated that, pending the presence of suitable habitat, the following species should be addressed in an endangered species analysis: Indiana Bat, Northern Long-eared Bat, Eastern Prairie Fringed Orchid, and the Snuffbox Mussel.

The Roadmap indicated that the ESA should cover criteria pollutants and hazardous air pollutants (HAP) for the proposed project. Cronus contacted the USEPA to request a specific list of pollutants that needed to be evaluated as part of the ESA. The USEPA requested that the following pollutants be addressed in the analysis: carbon monoxide (CO), oxides of nitrogen (NO_X), particulate matter (PM), sulfur dioxide (SO_2), 1,3-Butadiene, arsenic, beryllium, cadmium, chromium, cobalt, formaldehyde, manganese, mercury, methanol, nickel, PAH, propylene oxide, and selenium.

1.1 Endangered Species Information

The Indiana Bat, an endangered species, is a migratory species moving between wintering and summer habitats. Wintering habitats consist of karst regions and other cave-like habitats, while summer habitats consist of wooded areas along riparian zones and upland wooded areas.[1] Preferred winter habitat temperatures are typically below 10°C (50°F) with infrequent drops below freezing due to the metabolic requirements of the species. Summer habitats consist of trees with exfoliating bark along riparian zones and roost in trees within canopy gaps in forests, fence lines, or along wooded edges. Insectivorous feeding occurs in semi-open to closed forested habitats, forest edges, and in riparian zones. Based on a review of the project area, by the USEPA and Cronus, it was determined that no habitat is present within the project area.

The Northern Long-eared Bat, which has been proposed as an endangered species, is a migratory species moving between wintering and summer habitats. Wintering habitats consist of large caves and mines that have large passages and entrances with extremely high humidity. Summer habitats consist of wooded areas along riparian zones, upland wooded areas, and caves/mines.[2] Preferred winter habitat consists of constant temperatures and high humidity levels with no air currents. Summer habitats consist of trees with exfoliating bark along riparian zones, mine/caves, and have also been found in barns and sheds. Insectivorous feeding occurs in semi-open to closed forested habitats, forest edges, and in riparian zones. Based on a review of the project area, by the USEPA and Cronus, it was determined that no habitat is present within the project area.

[1] http://www.fws.gov/midwest/Endangered/mammals/inba/inbafctsht.html
[2] http://www.fws.gov/midwest/endangered/mammals/nlba/pdf/NLBAFactSheet27Sept2013.pdf

The Eastern Prairie Fringed Orchid occurs in numerous habitats from mesic prairie to various wetland types (sedge meadows, marsh edges, and bogs).[3] It thrives best in full sun, grassy habitat with little or no woody growth. As with all orchids, this plant requires mycorrhizae (fungal symbiont) for seed germination. The eastern prairie fringed orchid is threatened because habitat was lost to agriculture. More recently, decline of the plant is due to habitat loss from drainage of wetlands, primary ecological succession (establishment of woody vegetation), competition from non-native species, and over collection by plant collectors. Based on a review of the project area, by the USEPA and Cronus, it was determined that habitat is present within the project area.

The Snuffbox Mussel has been known to occur in Douglas County within the Embarrass River. Small to medium sized streams with swift currents and floors with coarse sand and gravel provide preferred habitat for the Snuffbox Mussel. The Snuffbox is threatened by nonnative species, dams, and sedimentation caused by poor agricultural land use.[4] A recent report, "Freshwater Mussels of the Kaskaskia River Basin," prepared by the Illinois Natural History Survey in February 2013, indicated that the snuffbox mussel is not present in the Kaskaskia River. Based on these findings, Cronus requested a decision by the US Fish and Wildlife Service (US FWS) to determine if the Snuffbox could be removed from consideration in the ESA. On June 12, 2014 Cronus was notified via email by the USEPA that the Snuffbox could be removed from consideration in the ESA.

As a result of initial discussions with the USEPA, the Indian Bat and Northern Long-eared Bat were removed from consideration. In a June 12, 2014 email the USEPA indicated that the Snuffbox Mussel could be removed from consideration in the ESA. As a result, the Eastern Prairie Fringed Orchid is the only remaining species for consideration in the ESA.

Upon review of aerial photography, topographic maps, National Wetland Inventory Maps, and Land Use Maps of the project area, it has been determined that habitat for the Eastern Prairie Fringed Orchid is present within three kilometer (km) of the project site. Habitat for the Eastern Prairie Fringed Orchid is only present in a small portion of the 3-km radius of the Facility, since a majority of the surrounding area is disturbed agricultural land.

Deposition modeling was requested in the Roadmap for several of the pollutants from the Facility. The Deposition Modeling Report is included in Appendix B of this report. The deposition modeling was conducted using the American Meteorological Society/Environmental Protection Agency Regulatory model (AERMOD) version 13350. AERMOD is an EPA approved steady state Gaussian plume model capable of modeling multiple sources in simple and complex terrain. The deposition modeling was based on the procedures in the Screening Level

[3] http://www.fws.gov/ midwest/endangered/plants/epfo.html
[4] http://www.fws.gov/midwest/endangered/clams/snuffbox/SnuffboxFactSheet.html

Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities[5]. Regulatory default settings were used for this modeling analysis, including:

- Receptor elevation
- Boundary layer parameters calculated by AERMET
- Calm and missing data treatment
- Stack tip downwash
- Direction specific building downwash

Nitrogen oxides and sulfur dioxide emissions were evaluated to indicate if their emission rates would pose a threat to the survival rate of the plant species of concern. A detailed analysis is provided in Section 2.1 Nitrogen and Sulfur Deposition Analysis.

Impacts resulting from CO emissions from the Facility were compared to background to determine if potential impacts would result from the proposed Facility and are included in Section 2.2.

A HAP impact evaluation for the list of HAP provided in the Roadmap by the USEPA is located in Section 2.3.

Particulate Matter (PM) and PM less than 10 microns (PM_{10}) emissions from the Facility were evaluated for potential impacts to the species of concern. The analysis is provided in Section 2.4 of this document.

1.2 Project Location

The Facility is located on the north side of Illinois Route 36 approximately one mile west of Tuscola, Illinois. The UTM Coordinates of the Facility are 386290.40 North and 4405724.52 East with NAD 83 datum. The Facility consists of approximately 300 acres of land.

1.3 Facility Emissions

The Facility's emissions qualify it as a major stationary source of CO, NO_X, and PM less than 10 microns (PM_{10}), and PM less than 2.5 microns ($PM_{2.5}$). $PM_{10,}$ $NO_{X,}$ CO, $SO_{2,}$ and HAP modeling were conducted to determine maximum annual deposition within a 3-km radius of the

[5] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.

Facility. The Facility emissions for these pollutants at maximum operating design capacity are provided on Table 1.2-1:

Table 1.2-1 Maximum and Permitted Emissions

Pollutant	***Maximum Operating Capacity (ton/yr)***	***Proposed Permitted Limits (ton/yr)***
CO	407	253.4
PM_{10}	166	133.6
$PM_{2.5}$	164	126.6
SO_2	5.0	5.0
NO_x	139	120.8
Inorganic HAP		
Arsenic	7.43E-04	
Beryllium	4.46E-05	
Cadmium	4.09E-03	
Chromium	5.20E-03	
Cobalt	3.12E-04	
Manganese	1.41E-03	
Nickel	7.81E-03	
Mercury	9.67E-04	
Selenium	8.92E-05	
Organic HAP		
Formaldehyde	4.68	
Methanol	2.58	
PAH	9.20E-03	
Propylene Oxide	1.21E-01	
1,3-Butadiene	1.82E-03	

Emissions at maximum operating capacity were calculated assuming 8,760 hours per year (hr/yr) at maximum site ratings utilizing emissions controls. The proposed permitted emission limits are less than the modeled emission rates from the Facility except for SO_2, which is identical. Modeling was performed on emissions at maximum operating capacity; therefore, the modeled impacts provided in this analysis are slightly overestimated because they are based on the higher value.

Section 2.0 Pollutant Analysis

2.1 Nitrogen and Sulfur Deposition Analysis

Excess levels of nitrogen have the potential for negative impacts on the plant species of concern. Nitrogen levels above normal deposition can cause, among other things, the plants to be crowded out by other common, aggressive plants, which can lead to species decline. Sulfur deposition in excess of normal annual deposition can lead to a pH change of native soil, resulting in a loss of suitable habitat and species decline. The background data for nitrogen and sulfur deposition modeling is contained in Appendix C. To be conservative, oxides of nitrogen were modeled in place of nitrogen, and oxides of sulfur were modeled in place of sulfur for the Facility and the facilities in the vicinity provided by the IEPA. This will overestimate nitrogen and sulfur deposition rates from the Facility. For clarification purposes, the analysis will refer to oxides of nitrogen and oxides of sulfur as N and S respectively.

There is no information available that indicates the concentrations of N or S deposition background levels in the vicinity of the proposed project. The closest deposition monitoring station, located in Bondville, Illinois, was chosen as background because it is the most representative of where the emissions of the proposed project will be deposited. The Bondville Monitoring Station is part of the USEPA's Clean Air Status and Trends network.

The Bondville Monitoring Station currently lists data up to and including 2012 (Appendix C). Predictive deposition modeling from the proposed Facility was run for the years 2008 to 2012. By taking the highest deposition background concentration of N from 2008 to 2012 (7.61 kilograms per hectare per year [kg/ha/yr])[6] and comparing it to the highest modeled deposition rate from 2008 to 2012 (271.50 kg/ha/yr)[7], the overall increase of nitrogen deposition from Cronus and the surrounding facilities will be 35.67 times higher than background. The N deposition rate solely from Cronus is 1.306 kg/ha/yr[8] or 17 percent of background. (The modeled deposition rates were converted using the following equations: 0.1306 grams per meters squared [g/m^2] x 10,000 m^2/1 ha = 1,306 g/ha/yr; 1,306 g/ha/yr x 0.001 g/kg = 1.306 kg/ha/yr.)

The additional N deposition from Cronus alone will not likely cause adverse impacts to the surrounding flora. The zone of N deposition at the highest receptor and a rate of 1.306 kg/ha/yr is an extremely small area located at the northeast fence line and the neighboring property well within the 3-km radius of the Facility.[9] Based on a review of land use/land cover for the surrounding area, potential habitat for the Eastern Prairie Fringed Orchid would be west and southwest of the proposed Facility which has a much lower deposition rate (0.10 kg/ha/yr).[10] As indicated above, the N deposition resulting from the proposed Cronus Facility alone is not a significant increase and will not result in any adverse impacts. Although the maximum deposition rate was requested to be used in the analysis, the impacts associated

[6] CASTNET Database, USEPA, 2014. Data can be found at http://www.epa.gov/castnet/javaweb/site_pages/BVL130.html.
[7] Based on a maximum deposition of 27.15 g/m^2, Appendix B, page B-7.
[8] Based on a maximum deposition of 0.1306 g/m^2, Appendix B, page B-7.
[9] Appendix B, Figure 13.
[10] Appendix B, Figure 13.

with the proposed Facility demonstrate that neighboring facilities contribute over 99% of the total N deposition for the project area.

A deposition rate of 1.306 kg/ha/yr N added to the background level of 7.61 kg/ha/yr N would give a maximum annual total N deposition rate of 8.916 kg/ha/yr. Compared to the benchmark of 5 to 10 kg/ha/yr N, the deposition rate of 8.916 kg/ha/yr is within the allowable parameters for no adverse impacts to the species of concern.[11]

Although a total deposition rate of 8.916 kg/ha/yr of N, including background, would be deposited on an annual basis in the area of concern, only a small portion of the N deposited would be available for plant uptake. Primary uptake of N by plants is in the form of ammonium or nitrate and eventually converts to amino acids, nucleic acids, and various other N containing molecules within the plant. The ratio of N to carbon in plant tissues is approximately 1:6, resulting in N being the most common limiting factor for plant growth. Available N is obtained from non-biological processes (e.g. lightning), free-living bacteria, and select legumes and actinorhizal species of plants. If the N is not converted to ammonium or nitrate by one of these processes, it will remain useless to the plant and remain in the rhizosphere. Most N utilized by plants is fixed in the rhizosphere and additional organic N may migrate to this zone around the plants roots from the O horizon of the soil profile or from fertilizer applications. Therefore, only a fraction of the N deposition will be available for plant uptake.

Taking into account the N cycle, a more accurate deposition rate of 1.306 kg/ha/yr N, and the fact that the surrounding land is used primarily for agriculture, and the application of nitrogen based fertilizers, it is not anticipated that the addition of N from Cronus will adversely impact the species of concern.

During the same time frame from 2008 to 2012, Bondville had a maximum sulfur deposition background concentration of 8.54 kg/ha/yr.[12] Compared to the maximum modeled deposition rate from 2008 to 2012 (39.8 kg/ha/yr[13] or approximately 4.66 times background). The SO_2 deposition solely from Cronus is 0.0173 kg/ha/yr[14] or 0.20 percent of background. Sulfur emissions from Cronus are not expected to be significant.

Site-specific information as to actual concentrations of N and S in background concentrations is not available for the Facility. Therefore, we estimated the background level based on the Bondville site and then attempted to determine what effect the additional N and S will have on the plant species. The proposed NO_X emissions increase resulting from the proposed facility

[11] Impacts of Nitrogen Deposition on California Ecosystems & Biodiversity, California Energy Commission, May 2006.
[12] Appendix C.
[13] Based on a Maximum Deposition of 3.98 g/m^2, Appendix B, Page B-7.
[14] Based on a Maximum Deposition of 0.00173 g/m^2, Appendix B, Page B-7.

will result in a less than 4% increase to the Douglas County NO_X emissions inventory. When the Facility is operated at maximum capacity; however, the Facility will be operated at permitted levels. The amount of N and S deposition is expected to be at de minimis levels. With that said, it is doubtful that the low levels of N and S deposition could actually benefit or harm the soils where the species of concern are located.

2.2 Carbon Monoxide Analysis

CO was evaluated in the same manner as the other pollutants in this evaluation. There was no Effect Screening Level (ESL) for CO; therefore, the National Ambient Air Quality Standard (NAAQS) for CO was used as the ESL for this analysis. As a result, the modeled rate was added to the background concentration, provided by the IEPA, and compared to the NAAQS limit. The combined CO rate was less than the NAAQS standard per the NAAQS analysis included in Dispersion Modeling Report contained in the PSD Application. As a result, no adverse effects are anticipated resulting from the increased CO emission rate associated with the proposed Facility.

2.3 Analysis of Hazardous Air Pollutants

With the operation of the fertilizer plant, Cronus will release a variety of different chemicals that are categorized as HAP under the Clean Air Act. The HAP emission table is included in Appendix D. HAP can be harmful to human health and the environment if found in sufficient levels. HAP will disperse over a wide area once they exit the Facility causing HAP to be deposited into areas considered to be potential habitat for the listed species referenced in the Roadmap.

A HAP analysis was prepared following the guidelines set forth in the "Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities."[15] Calculations were completed for soil (Appendix E for the list of HAP provided by USEPA in the "Roadmap".) To be conservative in the risk estimations, the highest modeled deposition rates from the Facility were used in the HAP analysis.

The HAP deposition rates from the Facility were calculated using the chemical specific properties located in Volume 2 Appendix A of the Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. The media specific soil calculations were calculated using Volume 3 Appendix B of the Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities and are presented in Appendix E.

[15] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.

The HAP were analyzed to determine if they exceed a media specific ecological benchmark. Metal HAP were also compared to the soil background levels within metropolitan statistical areas in Illinois. All of the HAP were below background and or benchmark levels (see Appendix E).

2.4 PM/PM_{10} Analysis

PM/PM_{10} deposition can have a negative impact on plant species. As PM/PM_{10} accumulates on plant leaves, the stomata can be covered. If the $PM/PM_{10}/PM_{2.5}$ sufficiently covers the stomatal openings on the leaf surface, the plants can suffer from reduced levels of photosynthesis and in turn reduce reproduction rates.

The PM/PM_{10} benchmark of 10 $g/m^2/yr$ from the ExxonMobil Joliet Refinery ESA was used in this assessment. The highest modeled PM deposition rate, which includes Cronus and surrounding sources, is 27.15 $g/m^2/yr$[16] and occurs just west of the proposed Facility near the neighboring chemical manufacturing Facility. A maximum deposition rate of PM for areas with potential habitat for the Eastern Prairie Fringed Orchid, which is southwest of the proposed Facility, is 0.2 $g/m^2/yr$[17].

The highest PM/PM_{10} deposition rate modeled solely from Cronus's proposed Facility is 0.442 $g/m^2/yr$.[18] There is no measurable PM deposition southwest of the proposed Facility where potential habitat for the Eastern Prairie Fringed Orchid is located. Therefore, the PM deposition rate of 0.44 $g/m^2/yr$ was used in this analysis as a worst-case scenario and is roughly 4.42 percent of the benchmark used in the ExxonMobil Joliet Refinery ESA which was 10 $g/m^2/yr$. Therefore, although there is potential for adverse effects to the species of concern from the $PM/PM_{10}/PM_{2.5}$ deposition, the overall risk is considered to be insignificant.

2.5 Ammonia Analysis

The USEPA requested that ammonia be included as a pollutant in the ESA. Ammonia releases from the ammonia plant will be directed to the flare and converted to N, which is accounted for in the Nitrogen analysis. During normal operation a slight ammonia slip resulting in small ammonia emissions, up to 2 ppm, will be exhausted through the primary reformer exhaust stack. Ammonia emissions from the proposed facility are anticipated to be negligible.

[16] Appendix B, page B-7.
[17] Appendix B, Figure 5.
[18] Appendix B, page B-7.

Section 3.0 Conclusions

Based on the deposition rates of nitrogen and sulfur compared to background deposition levels, the increased deposition from the proposed Facility will not have a significant impact on the Eastern Prairie Fringed Orchid. From a meteorological viewpoint, the increase of nitrogen and sulfur would be difficult to track on an annual basis because changing climactic conditions have an effect on the annual background deposition levels. There is no readily available literature indicating that an increase of such a small amount will have negative impacts on any of the species of concern. Therefore, the proposed nitrogen and sulfur emissions will not negatively impact any of the species of concern.

CO and HAP emissions from the source are not expected to have adverse impacts on the species of concern.

Based on the benchmark level for PM_{10} deposition, which is nearly 23 times greater than the maximum modeled PM/PM_{10} deposition rate from the proposed Facility, there is no reason to believe that emissions will result in any significant impacts to the Eastern Prairie Fringe Orchid.

Upon review of available support documentation and modeling results the potential for adverse impacts to the species of concern appears to minimal. We recommend that a "Finding of No Significant Impact" determination be issued by the USEPA.

Appendix A

Recommended Scope of Analysis for Endangered Species Evaluation

Recommended Scope of Analysis
For
Endangered Species Evaluation

Purpose of analysis:

The analysis is intended to determine whether the emissions from project may affect federally listed threatened and endangered species in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 USC 1531 et seq) (Act). This scope of analysis, or roadmap, incorporates USEPA's ecological risk assessment process to address the decision points in section 7 of the Act. Portions of the USEPA's draft Screening Level Ecological Risk Assessment (SLERA) Protocol for Hazardous Waste Combustion Facilities (EPA 530-D-99-001A) provide guidance for this analysis. Although this guidance was developed to assess the impact of hazardous waste combustion facilities on the environment, it offers general approaches that may be helpful for assessing the fate of chemicals released to the air from various types of industrial facilities.

Overall, the evaluation should focus on only those emissions from the proposed expansion at the facility. To complete this analysis an understanding of the background concentrations and deposition patterns is needed. The anticipated emissions from permitted, but not yet operational, facilities other than the facility being permitted should be included in background. The anticipated concentration in air or deposition at sites that have the potential for supporting listed species should be compared against no observed adverse effects level (NOAEL) benchmarks thought to be protective of the appropriate group (e.g., threatened and endangered species). The evaluation should look at the incremental addition in the context of background concentrations.

Benchmarks:

For these analyses, commonly accepted NOAEL benchmarks should be used. Where more than one appropriate benchmark can be found the more protective value should be used, unless an explanation is given to justify a less protective benchmark. When there is no commonly accepted benchmark, there should be a search of the scientific literature for relevant toxicity information to provide a basis for risk assessment for the species of concern. For the Indiana bat, the USEPA Region 5's, Resource Conservation and Recovery Act Ecological Screening Levels (http://www.epa.gov/RCRIS-Region-5/ca/ESL.pdf and the USEPA Ecological Soil Screening Levels (http://www.epa.gov/ecotox/ecossl) for mammalian insectivores may be used to determine benchmarks.

Modeling protocol:

Modeling should follow the general guidance provided in Chapter 3 of USEPA's SLERA protocol for assessing chemical fate and transport. The modeling should show air concentrations and, where appropriate, deposition for the types of air pollutants evaluated. The air emissions resulting from the project should be modeled at the facility level, not on a unit basis. Total impacts should be evaluated looking at the combined effects of the vapor phase, particle phase and particle-bound phase of pollutants. AERMOD is an acceptable model for this analysis. For chemicals amenable to deposition (i.e., chemicals with a lower vapor pressure than benzene), models in the SLERA guidance should be used to estimate concentrations in soil, sediment and surface water in conjunction with relevant fate and transport parameters. Those compounds with high vapor pressures that do not readily partition to particle deposition will be excluded from the analysis. This analysis should use the "Fv" values found in the SLERA guidance document. "Fv" values representing the fraction of the air concentration in the vapor phase for compounds of potential concern are presented in Appendix A-2. "Fv" values are unitless numbers that are calculated using the compound specific vapor pressure, solubility, and melting point.

Assessment Area:

A specific assessment area has not been identified for this project. Typically, assuming that any species that may be affected within the same county as the facility is adequate. The U.S. FWS has identified the listed species that may be present in a specific area (http://www.fws.gov/midwest/endangered/lists/cty_indx.html), and the analysis for the initial ecological screening will assume that each species is exposed to the highest concentration in air, soil, water, and ingested plant tissue for each pollutant.

Background Levels:

Background levels of pollutants of concern should be located for soil, water and sediment. If actual values cannot be located, representative values may be used.

Suite of pollutants to consider:

The assessment should cover criteria pollutants and hazardous air pollutants (HAP) for this proposed project.

Types of impact to consider:

1. Short term: depending on the pollutant the investigation should compare worst 1-hr, 8-hr, and 24-hr concentrations in air with appropriate benchmarks for acute effects. The investigation should determine the impacts to food sources that may have taken up contaminants through soil, water and sediment, direct deposition on plants and plant tissue concentrations.
2. Long term: depending upon the pollutant, the investigation should compare the worst 1-yr of 5 concentration in air or deposition on soil with appropriate benchmarks for chronic effects.
3. For compounds that may accumulate, the investigation should evaluate estimated total deposition over the life of the project. These concentrations should be compared against benchmarks.

Appendix B

Deposition Modeling Report

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Section 1.0 Introduction

Cronus Chemicals, L.L.C. (Cronus) is proposing to construct an ammonia and urea production plant (Facility) near Tuscola, Illinois. This construction permit application was submitted to the Illinois Environmental Protection Agency (IEPA) in 2014. The construction project will be subject to the Endangered Species Analysis (ESA) for each of the criteria pollutants, ammonia and applicable hazardous air pollutants (HAP). The ESA requires the applicant to perform deposition modeling to assess any potential impacts on local threatened and endangered species. Conestoga-Rovers and Associates (CRA) was contracted by Cronus to perform the ESA. This report documents the results of a deposition modeling analysis including model selection, model input parameters, and results.

Section 2.0 Facility Description

The Facility is located west of Tuscola, Illinois in Douglas County. The UTM coordinates of the Facility are 386290.40, 4405724.52 with NAD 83 datum at an elevation of approximately 656 feet (ft) above sea level. A regional map indicating site location is presented in Figure 1.

Section 3.0 Facility Operations

The proposed urea production Facility will be constructed in Douglas County, Illinois near Tuscola. The site is located at 765 East US Highway 36, Tuscola, Illinois. The area directly adjacent to the proposed Facility is rural with industrial sites to the east and west of the proposed Facility and farmland to the north and south.

The proposed Facility contains two main processes: ammonia production (Ammonia Plant) and urea production (Urea Plant). In the urea fertilizer production process, ammonia is produced by the chemical combination of hydrogen (produced from natural gas and steam) and nitrogen (supplied from air). The ammonia is further chemically combined with carbon dioxide (CO_2) to produce urea. Cronus is seeking to permit the ammonia production at 2,789 tons per day (ton/day) of anhydrous ammonia and is seeking to permit urea production at 4,880 ton/day or urea.

The Ammonia Plant is based on a high efficiency natural gas reforming process. Major steps in ammonia production include:

- Natural gas compression and feed desulfurization
- Primary (steam) and secondary (air) reforming (to convert natural gas to synthesis gas for ammonia)
- Process air compression
- Carbon monoxide (CO) shift conversion (high and low temperature) to CO_2
- CO_2 removal
- Regeneration/Methanation/Purification
- Ammonia Synthesis Loop
- Ammonia (NH_3) Storage and Loadout
- Steam system
- Cooling water system

Urea is produced by reacting liquid ammonia and CO_2 collected as an offgas from the Ammonia Plant. Major processes in the Urea Plant include:

- NH_3 and CO_2 compression
- Synthesis
- Granulation
- Sizing
- Urea storage and loadout

The Facility layout is provided as Figure 2. A process flow diagram is presented in Figure 3.

3.1 Facility Sources

The Facility includes the following air emission sources:

Source ID	***Air Emission Source***
AES-02	Urea Granulator
AES-03	Primary Reformer
AES-05	Start-up Heater
AES-07	Auxiliary Boiler 1
AES-09	Emergency Generator 1
AES-17	Emergency Generator 2
AES-19	Emergency Generator 3
CT1-CT10	Cooling Tower Cells 1-10

Source ID	*Air Emission Source*
AES-11	Diesel Fire Pump
AES-12	Granulated Urea Loading Filter
AES-13	Ammonia Front-End Flare
AES-14	Ammonia Back-End Flare
AES-15	Ammonia Storage Flare
RD1-RD44, RD51	Haul Roads

Section 4.0 Facility Emissions

The Facility's emissions qualify it as a major stationary source of CO, Oxides of Nitrogen (NO_X), and Particulate Matter (PM) less than 10 microns (PM_{10}). and PM less than 2.5 microns ($PM_{2.5}$). PM_{10}, NO_x, CO, Sulfur Dioxide (SO_2), and hazardous air pollutants (HAP) modeling were conducted to determine maximum annual deposition within a 3-kilometer (km) radius of the Facility. The Facility emissions for these pollutants at maximum operating capacity are provided below:

Pollutant	*Tons per Year (ton/yr)*
CO	407
PM_{10}	166
$PM_{2.5}$	164
SO_2	4.97
NO_x	139
Inorganic HAPs	
Arsenic	7.43E-04
Beryllium	4.46E-05
Cadmium	4.09E-03
Chromium	5.20E-03
Cobalt	3.12E-04
Manganese	1.41E-03
Nickel	7.81E-03
Mercury	9.67E-04
Organic HAPs	
Formaldehyde	4.68
Methanol	2.58
PAH	9.20E-03
Propylene Oxide	1.21E-01
1,3-Butadiene	1.82E-03

The potential annual emissions at the Facility were calculated assuming 8,760 hours per year (hr/yr) at maximum site ratings utilizing emissions controls.

Section 5.0 Modeling Methodology

The accumulation of criteria pollutants within a 3-km radius was assessed by performing deposition-modeling analysis. Total deposition was determined for each criteria pollutant. The modeling was conducted utilizing the methodology outlined below.

5.1 Model Selection

The deposition modeling was conducted using the American Meteorological Society/ Environmental Protection Agency Regulatory model (AERMOD) version 13350. AERMOD is an EPA approved steady state Gaussian plume model capable of modeling multiple sources in simple and complex terrain. The regulatory default settings were used for this modeling analysis, including:

- Receptor elevation
- Boundary layer parameters calculated by AERMET
- Calm and missing data treatment
- Stack tip downwash
- Direction specific building downwash

5.1.1 Meteorological Data

Five years of preprocessed meteorological data from 2008 to 2012 were provided by the IEPA and were used for modeling analysis. Surface meteorological data was obtained from the National Weather Service (NWS) station located in Springfield, Illinois (Station Number 3822). Upper air data were obtained from Lincoln, Illinois (Station Number 833).

5.1.2 Building Downwash

A building downwash analysis using the latest version of Building Profile Input Program (BPIP) (Version 04274) was conducted and incorporated into the modeling analysis to account for potential effluent downwash due to buildings.

5.1.3 Reduced Load Analysis

Reduced load and start-up mode modeling were not considered in this deposition modeling. Deposition was modeled with the facility operating at full load conditions to provide a worst-case analysis of facility emissions.

5.1.4 Grid Selection

For each modeled criteria pollutant, Cartesian grid was established within a 3-km radius of the Facility. The following grid spacing was used for deposition modeling:

Distance from the Facility (m)	*Receptor Spacing (m)*
1,000	100
2,000	250
3,000	500
Facility Boundary	25

5.1.5 Modeling Input

Air dispersion modeling input parameters include UTM coordinates, stack height, pollutant emissions in pounds per hour (lb/hr) and grams per second (g/s), exit temperature, flow rate, diameter, area, and exit velocity for each source. HAP emissions from Facility sources were modeled at a unit emission rate of 1 g/s. The input parameters for modeled sources are included in Table 1.

5.1.6 Surrounding Source Inventory

An inventory of surrounding permitted sources within 3-km of the Facility was provided by the IEPA. The surrounding source input parameters are presented in Table 2. Surrounding sources were modeled with the same deposition modeling options as Facility sources. HAP emissions from surrounding sources were modeled with a unit emission rate of 1 g/s.

5.1.7 Other Modeling Options

In order to perform dry gas deposition modeling, land use categories were entered into the model for each wind direction sector for a 360-degree arc. Land use categories were determined using the AERSURFACE processor version number 8.5.1. The following land use designation was used for deposition modeling:

Wind Direction Sector (Degrees)	*Land Use Category*
5-235	Agricultural Land
235-295	Suburban Areas, Grassy
295-5	Agricultural Land

A particle size distribution was entered into the model for each source of particulate emissions. AERMOD uses two different methods to calculate deposition velocity of particles. Method 1 is used when a significant fraction (greater than 10 percent) of the total particulate mass has a diameter of 10 microns or larger. Method 2 is used when a small fraction (less than 10 percent of the mass) is in particles with a diameter of 10 microns or larger. Method 1 was used for facility particulate sources, using particle size distributions based on guidance from Appendix B.2 from AP-42 (9/90) and Table 3.1 from Screening Level Ecological Risk Assessment (SLERA) Protocol. Particle size distributions for each source are presented in Table 3. A conservative estimate of a particle density of 1 grams per cubic centimeter (g/cm^3) was assumed for all particles.

Dry gas deposition parameters were also entered into the model for each gaseous pollutant. Gas deposition parameters for each gaseous pollutant are included below. Values for SO_2 and NO_X were extracted from CALPUFF version 6.4. A generic set of gas values was extracted for CO from Perry's Chemical Engineering Handbook. Gaseous HAPs were conservatively modeled using CO gas values.

Pollutant	*CO*	*SO_2*	*NO_X*	*Gaseous HAPs*
Pollutant Diffusivity in Air (cm^2/s)	0.10	0.1509	0.1656	0.10
Pollutant Diffusivity in Water (cm^2/s)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Cuticular Resistance (s/cm)	1	1	5	1
Henry's Law Constant ($Pa\text{-}m^3/mol$)	1.063E+05	84.17	2525	1.063E+05

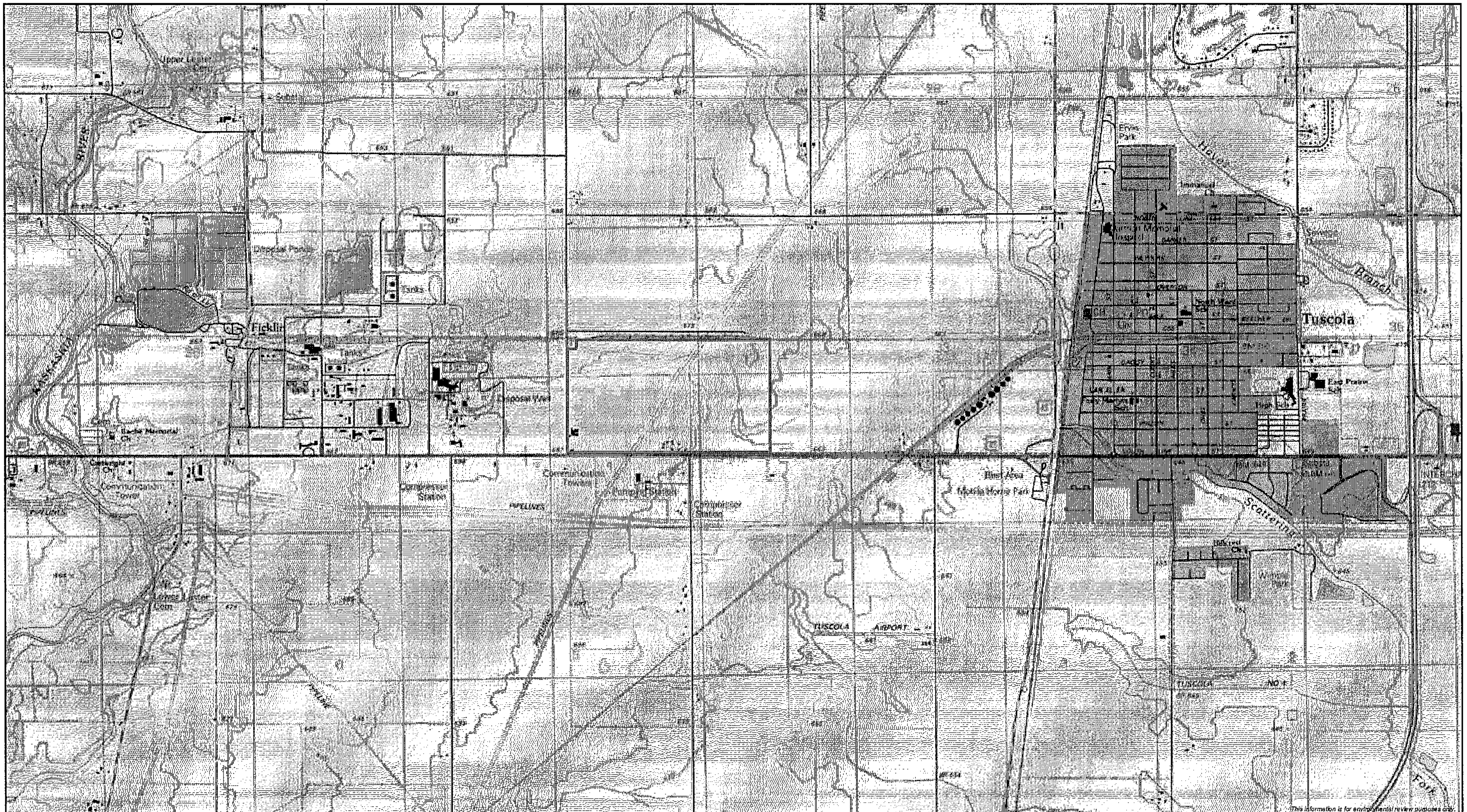
Section 6.0 Deposition Modeling Results

The results of the deposition modeling analysis are presented below. The deposition model was run for each year from 2008 to 2012 for both the Facility and the Facility plus surrounding sources. The results presented below are the highest concentration from the five years modeled for both scenarios. Deposition flux is calculated as an hourly rate considering 8,760 hr/yr.

	Facility		Facility + Surrounding Sources	
Pollutant	***Maximum Deposition (g/m^2)***	***Deposition Flux ($g/m^2/hr$)***	***Maximum Deposition (g/m^2)***	***Deposition Flux ($g/m^2/hr$)***
CO	1.203	1.37E-4	150.83	0.017
NOx	0.1306	1.49E-5	27.15	0.003
PM	0.442	5.05E-5	22.32	0.0026
SO_2	0.00173	1.97E-7	3.98	0.00045
Organic HAPs	1.39	1.59E-4	67.79	0.0077
Inorganic HAPs	0.0129	1.47E-6	78.04	0.0089

Deposition values for organic HAP and inorganic HAP are based on modeling with a unit emission rate of 1 gram per second. Deposition of individual HAP was calculated by multiplying unitized results by the respective HAP emission rates.

Concentration contours for each of the modeled criteria pollutants and HAP are presented in Figures 4 to 15.



Property Boundary

Figure 1
Cronus Chemicals Site
Tuscola, Illinois

M:\Clients\A-C\CCL_ArcGIS\2013\04_CCL_SiteMap.mxd | REVISED: 04/08/2013

DRAWN BY: JEBAKKEN

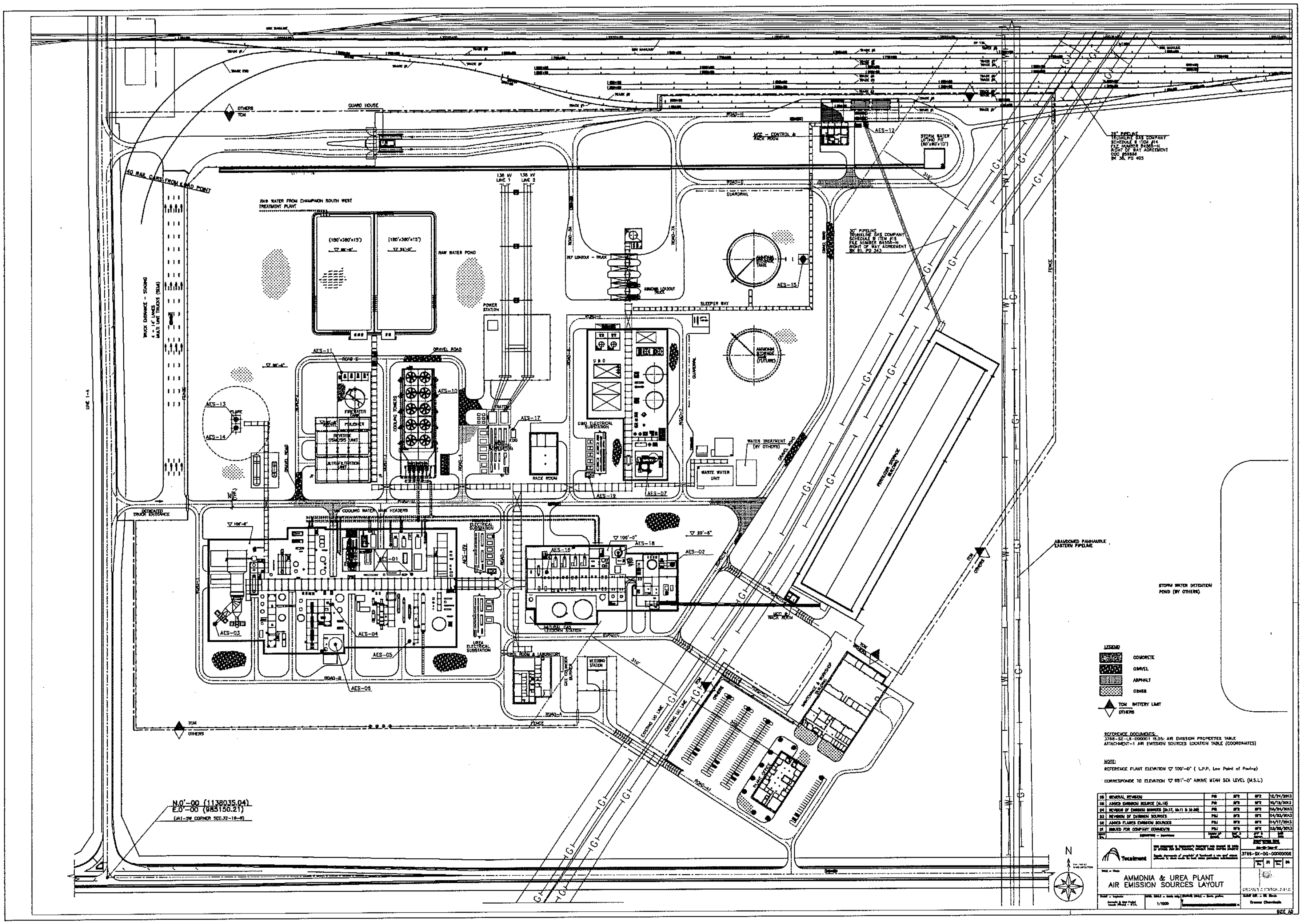

AMMONIA & UREA PLANT
AIR EMISSION SOURCES LAYOUT
AES-01
AES-02
AES-03
AES-04
AES-05
AES-06
AES-07
AES-10
AES-11
AES-12
AES-13
AES-14
AES-15
AES-16
AES-17
AES-18
AES-19
N.0'-00 (1138035.04)
E.0'-00 (983150.21)
RAW WATER POND
COOLING TOWERS
POWER STATION
RACK ROOM
GUARD HOUSE
WATER TREATMENT (BY OTHERS)
WASTE WATER UNIT
STORM WATER DETENTION POND (BY OTHERS)
ABANDONED PANHANDLE EASTERN PIPELINE
LEGEND
CONCRETE
GRAVEL
ASPHALT
GRASS
TCM BATTERY LIMIT
OTHERS
N

Figure 2

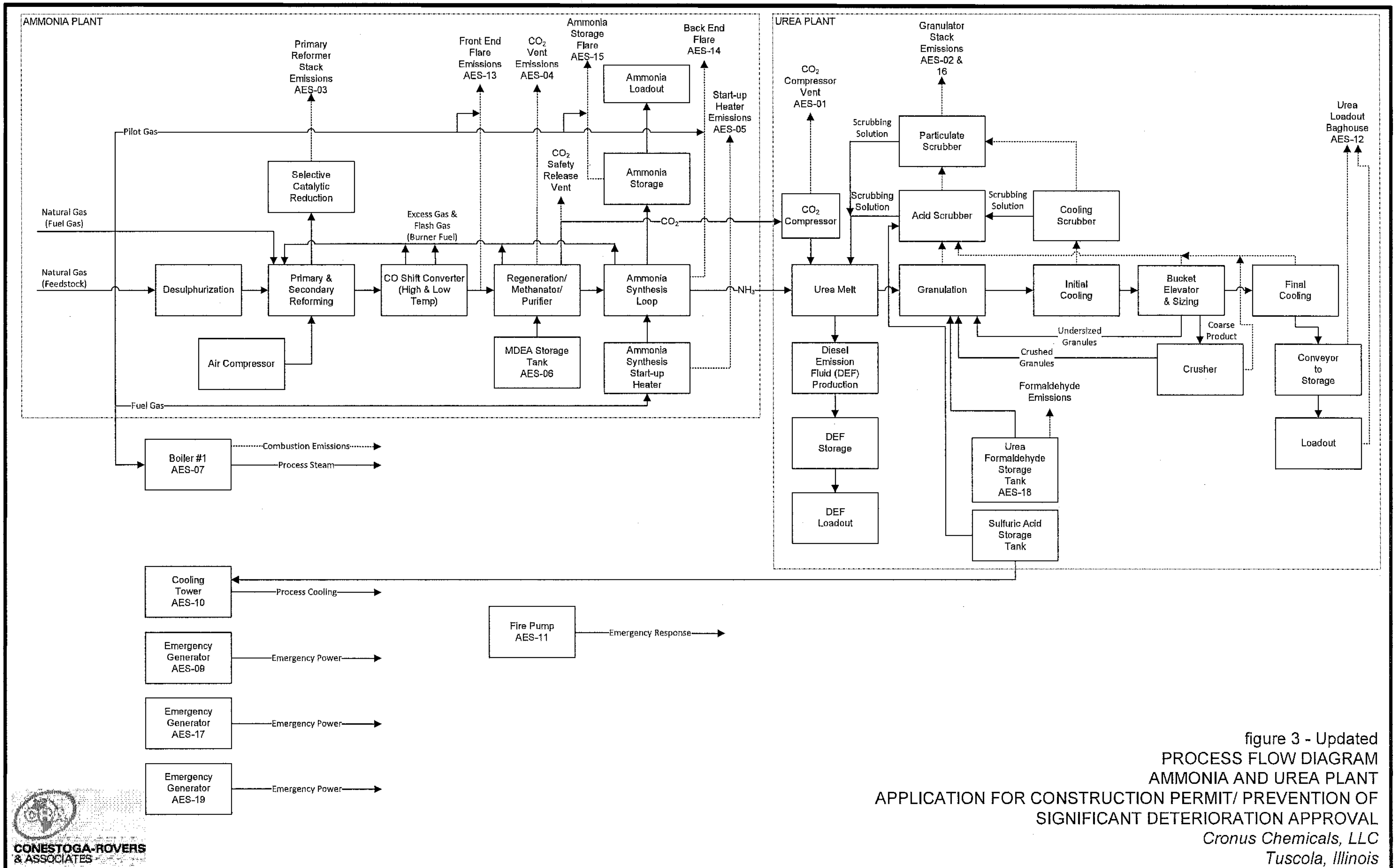
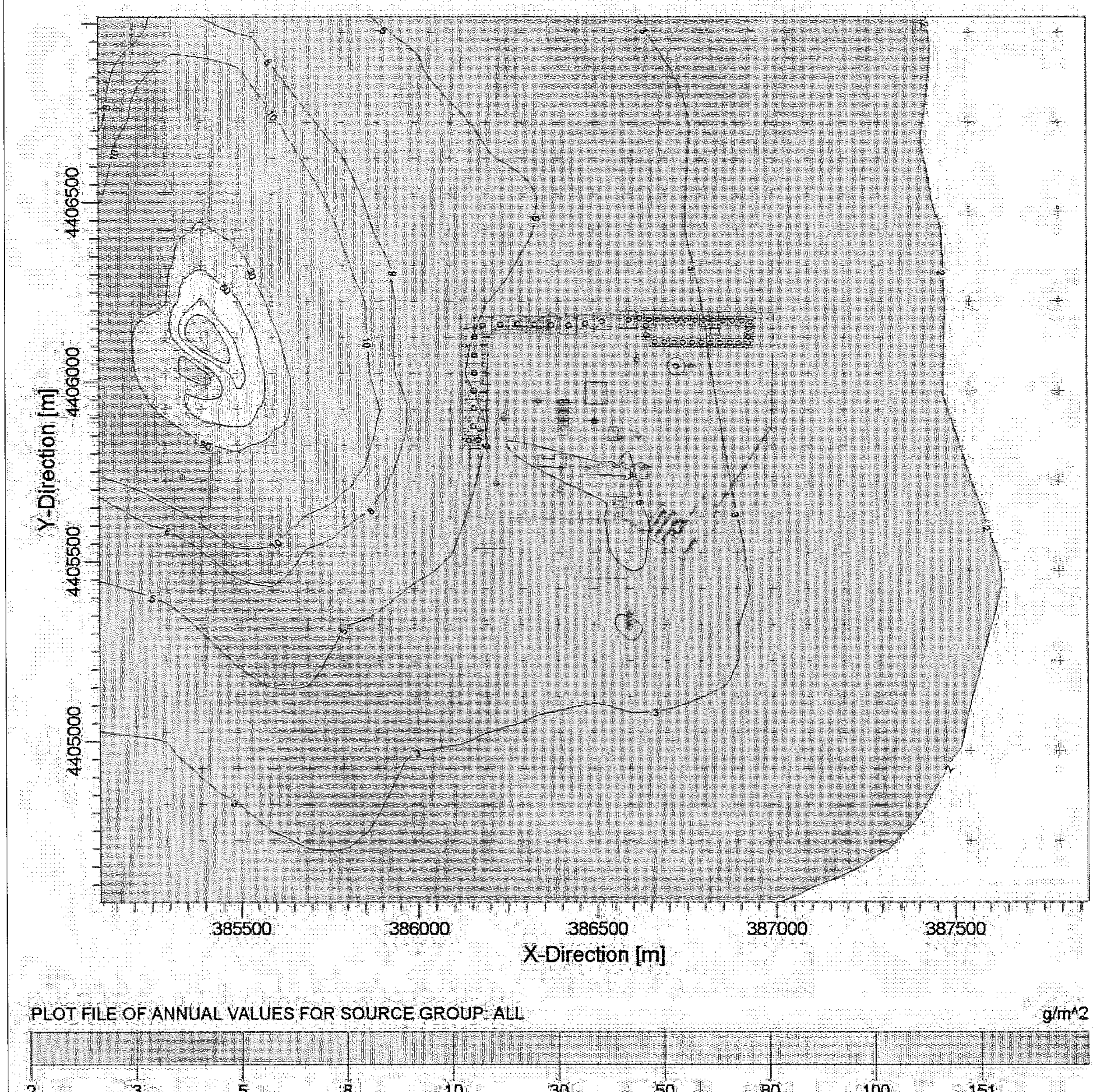


figure 3 - Updated
PROCESS FLOW DIAGRAM
AMMONIA AND UREA PLANT
APPLICATION FOR CONSTRUCTION PERMIT/ PREVENTION OF SIGNIFICANT DETERIORATION APPROVAL
Cronus Chemicals, LLC
Tuscola, Illinois

084547 (1); JAN 14/2014, SPRINGFIELD, Figure 1; Updated APR 17/14

Figure 4. CO Annual Deposition
Cronus Ammonia and Urea Plant



	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.
	Total Depos.		SCALE: 1:17,371 0 — 0.5 km
	150.82681	g/m^2	27/06/2014	084547

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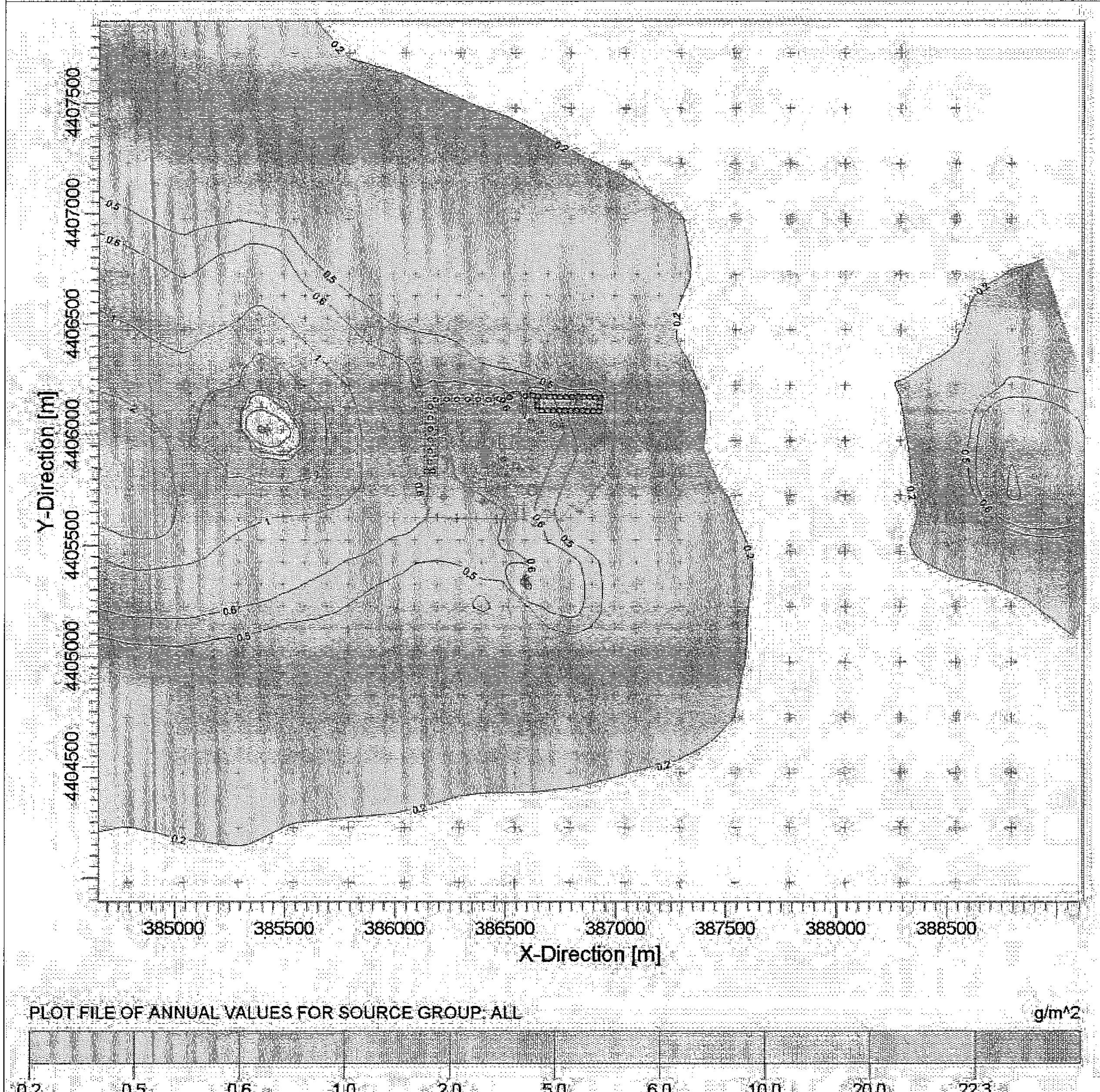
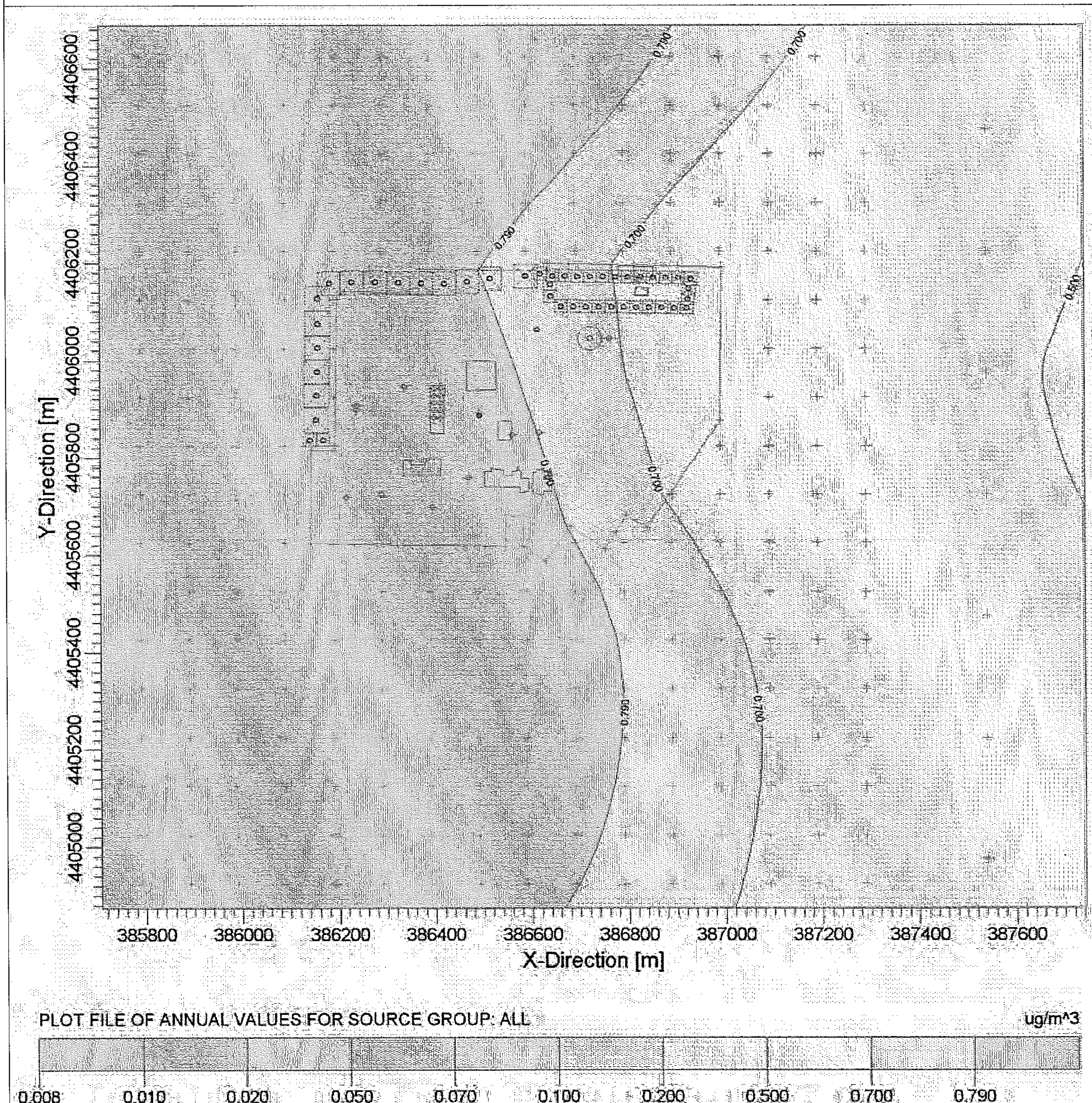
Figure 5. PM Annual Deposition
Cronus Ammonia and Urea Plant



	REGDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:28,042 0 0.5 km	
	22.32154	g/m^2	27/06/2014	084547

Figure 6. SO2 Annual Depostion
Cronus Ammonia and Urea Plant



	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		**Cronus Chemicals, L.L.C.**	
	Total Depos.		SCALE: 1:12,786 0 — 0.4 km	
	3.49821	**ug/m^3**	**27/06/2014**	**084547**

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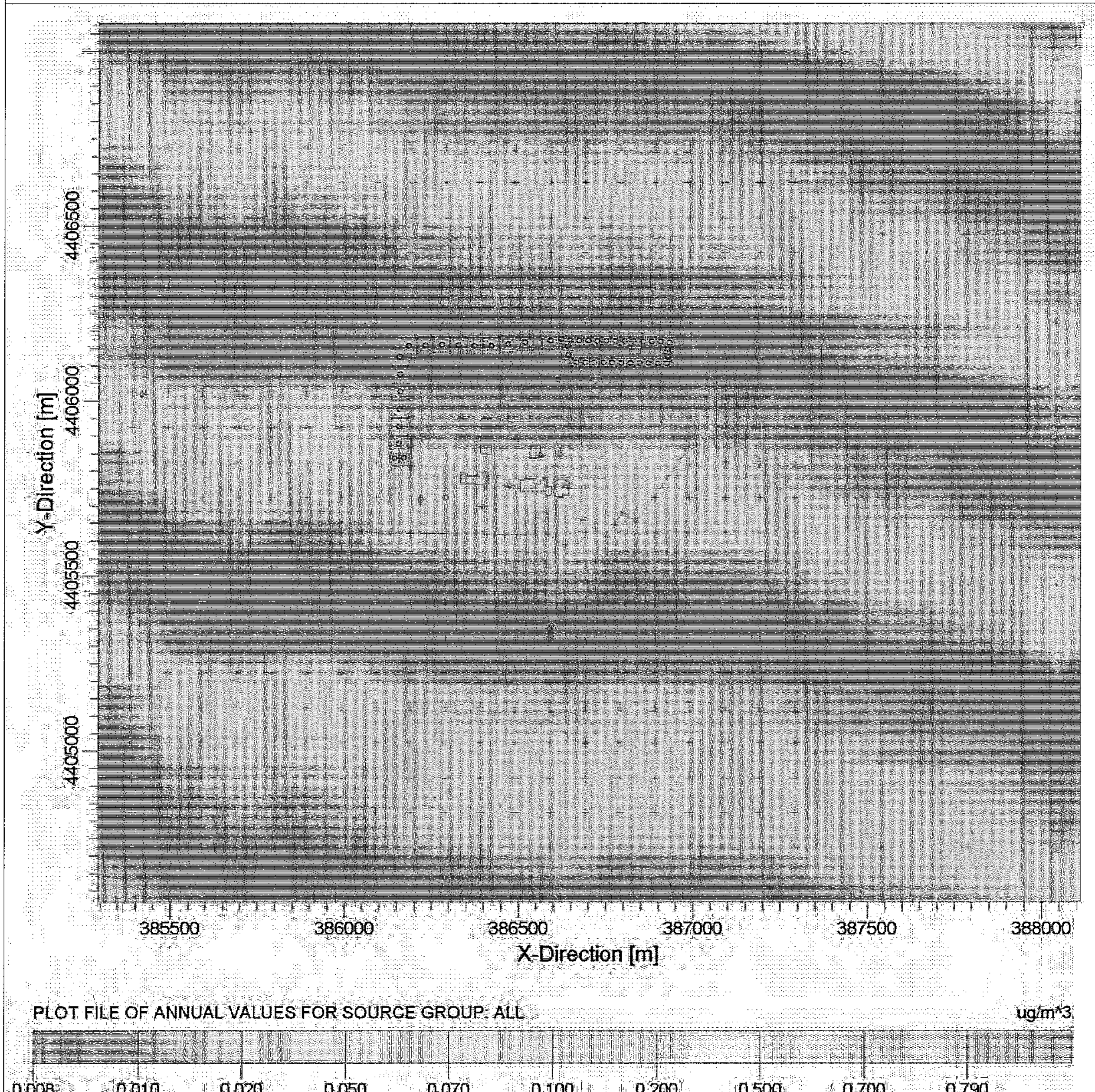
Figure 7. NO_2 Annual Deposition
Cronus Ammonia and Urea Plant



	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:17,697 0 ——— 0.5 km	
	27.15407	ug/m^3	27/06/2014	084547

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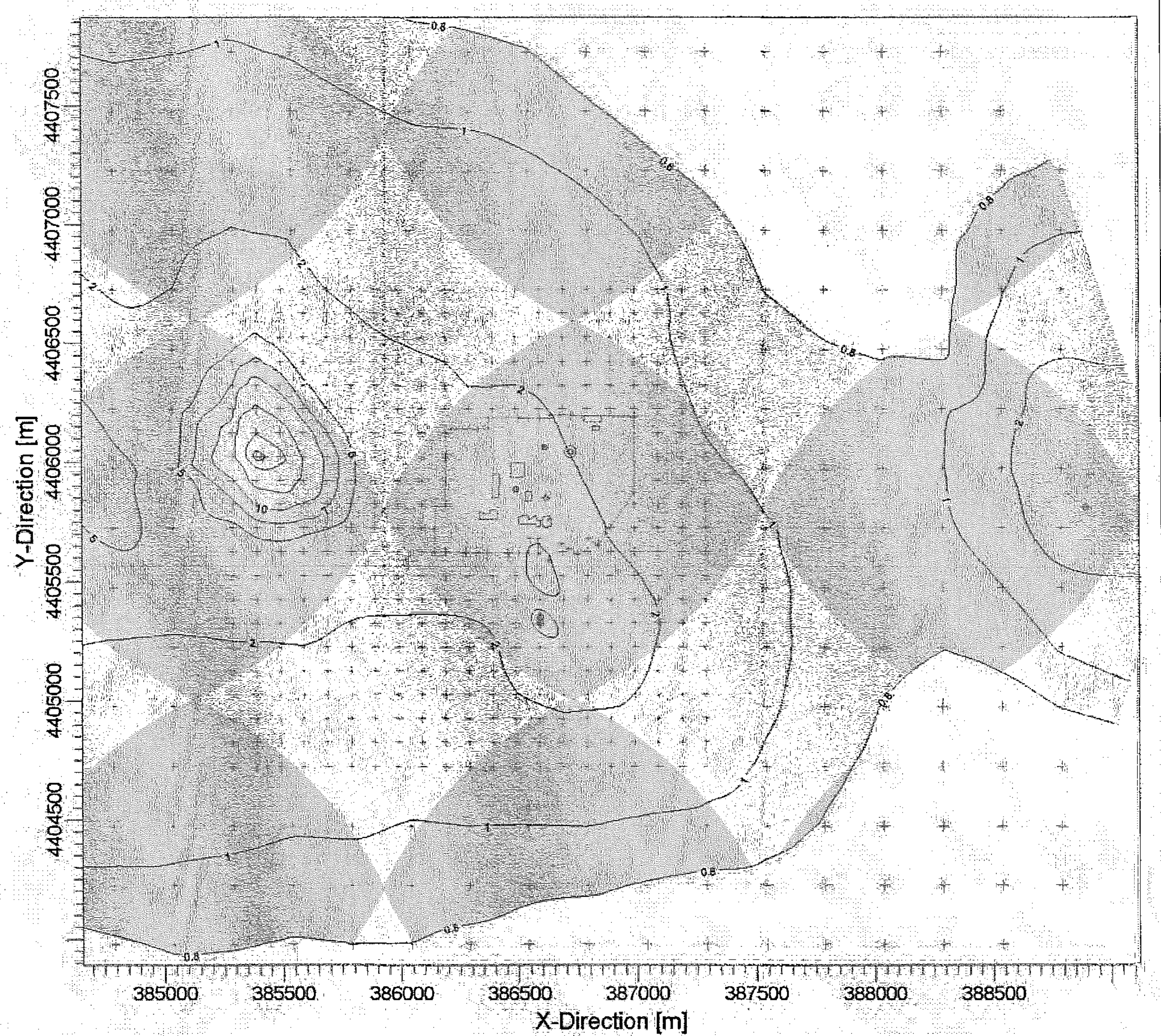
Figure 8. Inorganic HAPs Annual Depositions
Cronus Ammonia and Urea Plant

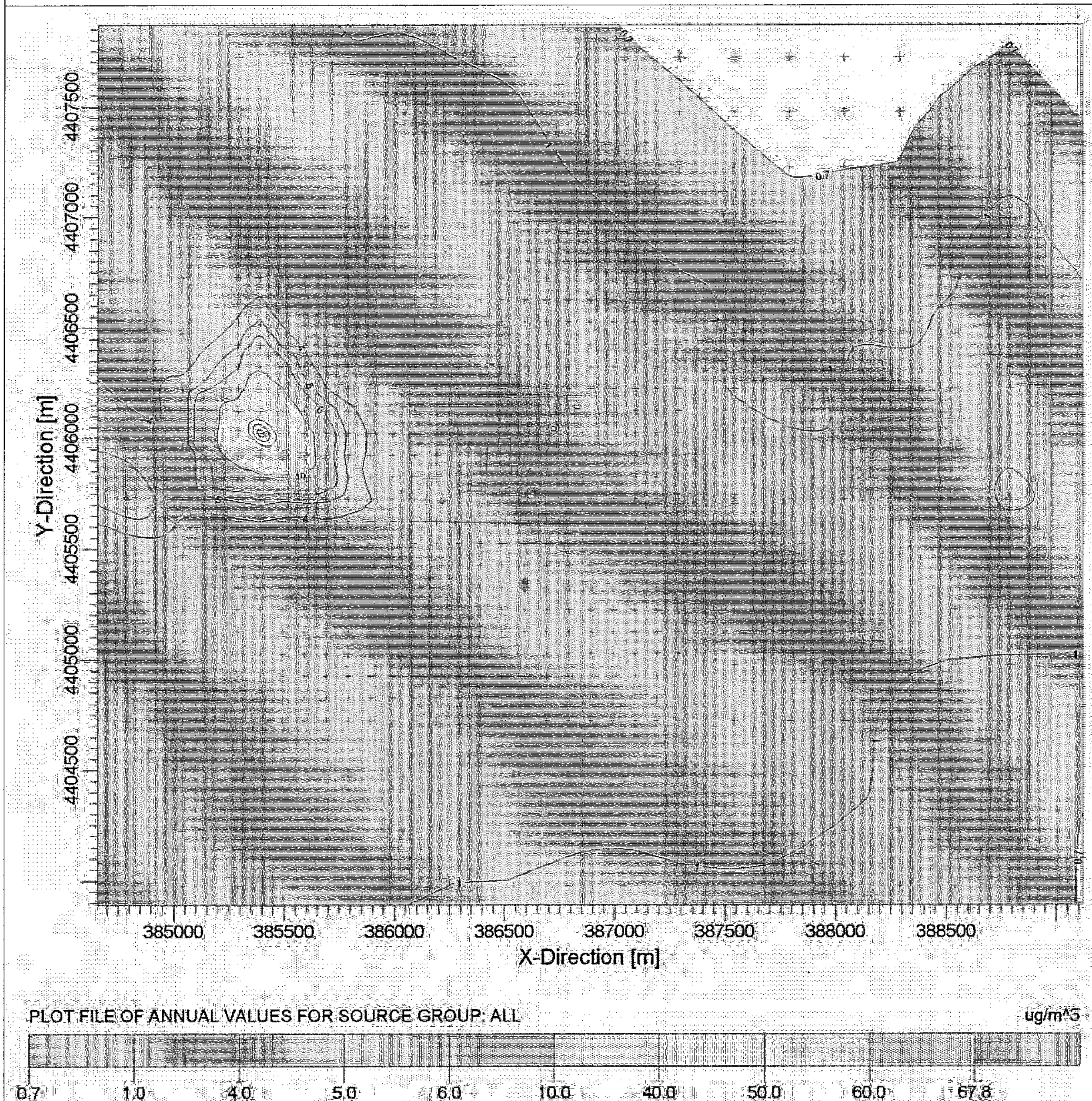


PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL g/m^2

0.8 1.0 2.0 5.0 7.0 10.0 20.0 50.0 70.0 78.0

	REGDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:28,042 0 0.5 km	
	78.03954	g/m^2	27/06/2014	

Figure 9. Organic HAPs Annual Deposition
Cronus Ammonia and Urea Plant



	NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		**Cronus Chemicals, L.L.C.**	
	Concentration		SCALE: 1:28,042 0 — 0.5 km	
	67.79	**ug/m^3**	**27/06/2014**	**084547**

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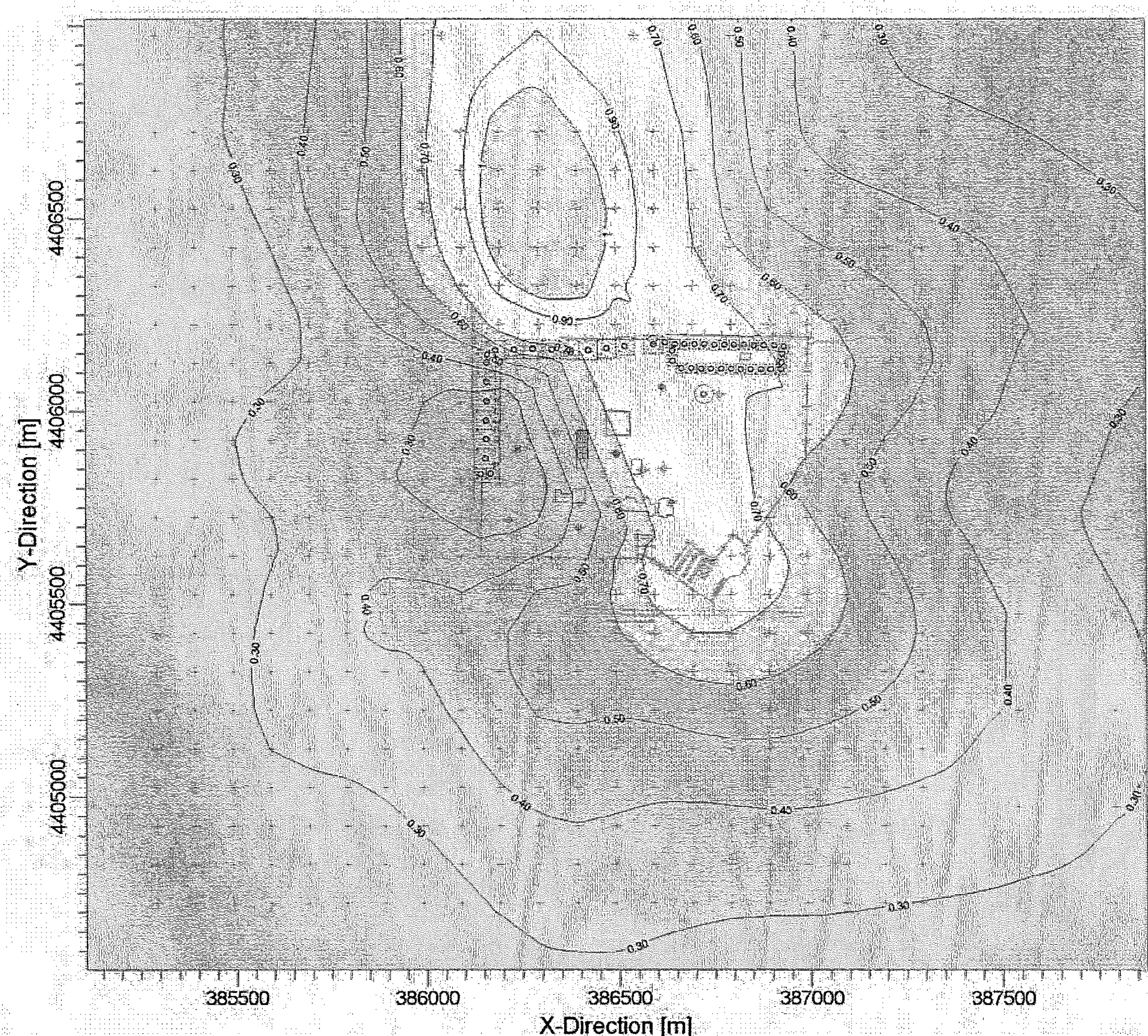
Figure 10. CO Annual Facility Deposition
Cronus Ammonia and Urea Plant



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

g/m^2

0.08 0.10 0.30 0.40 0.50 0.60 0.70 0.90 1.00 1.20

	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		**Cronus Chemicals, L.L.C.**	
	Total Depos.		SCALE: 1:17,371 0 0.5 km	
	1.20259	**g/m^2**	**27/06/2014**	**084547**

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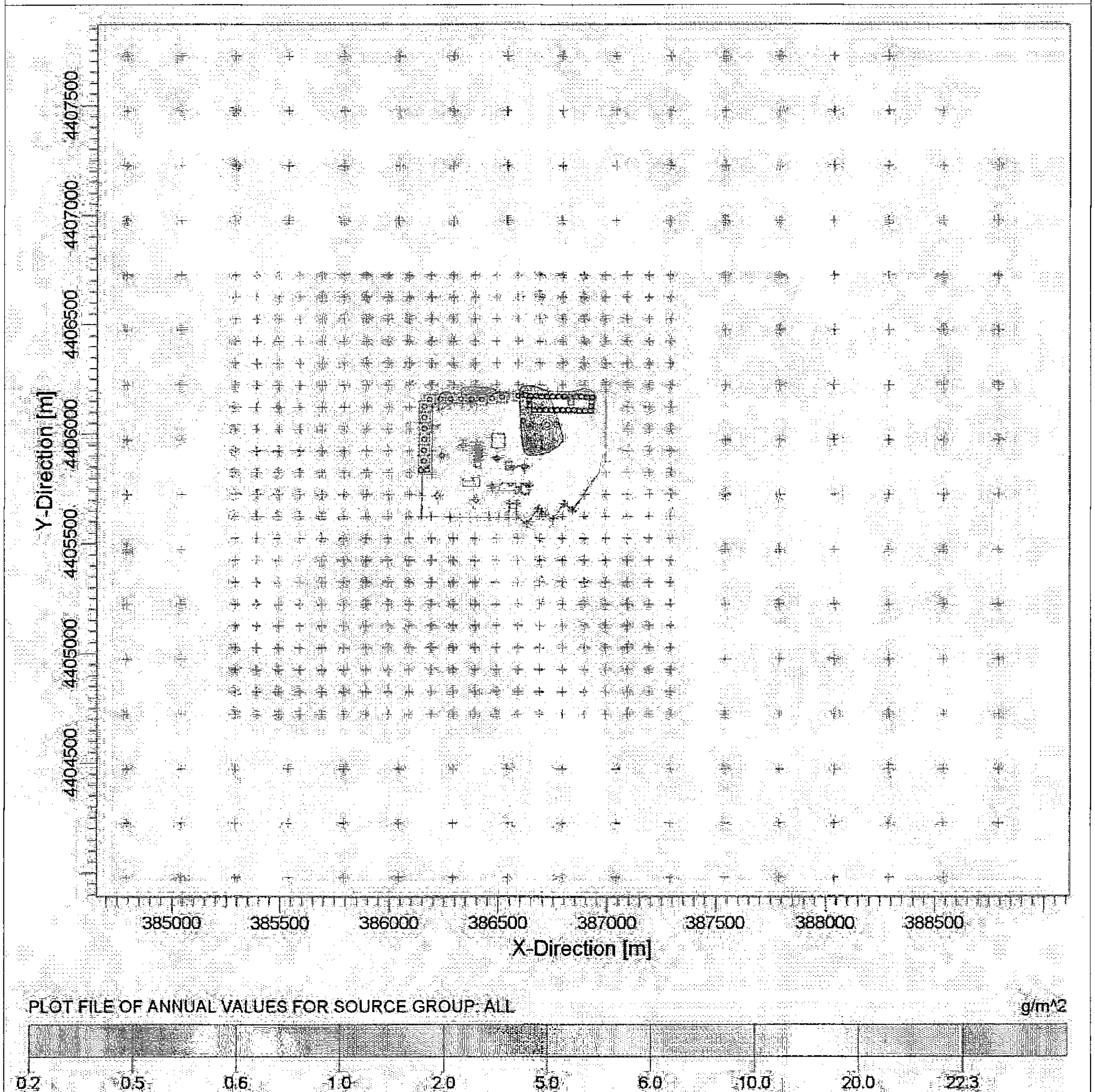
Figure 11. PM Annual Facility Deposition
Cronus Ammonia and Urea Plant



	REGDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:28,042 0 — 0.5 km	
	0.44156	g/m^2	27/06/2014	084547

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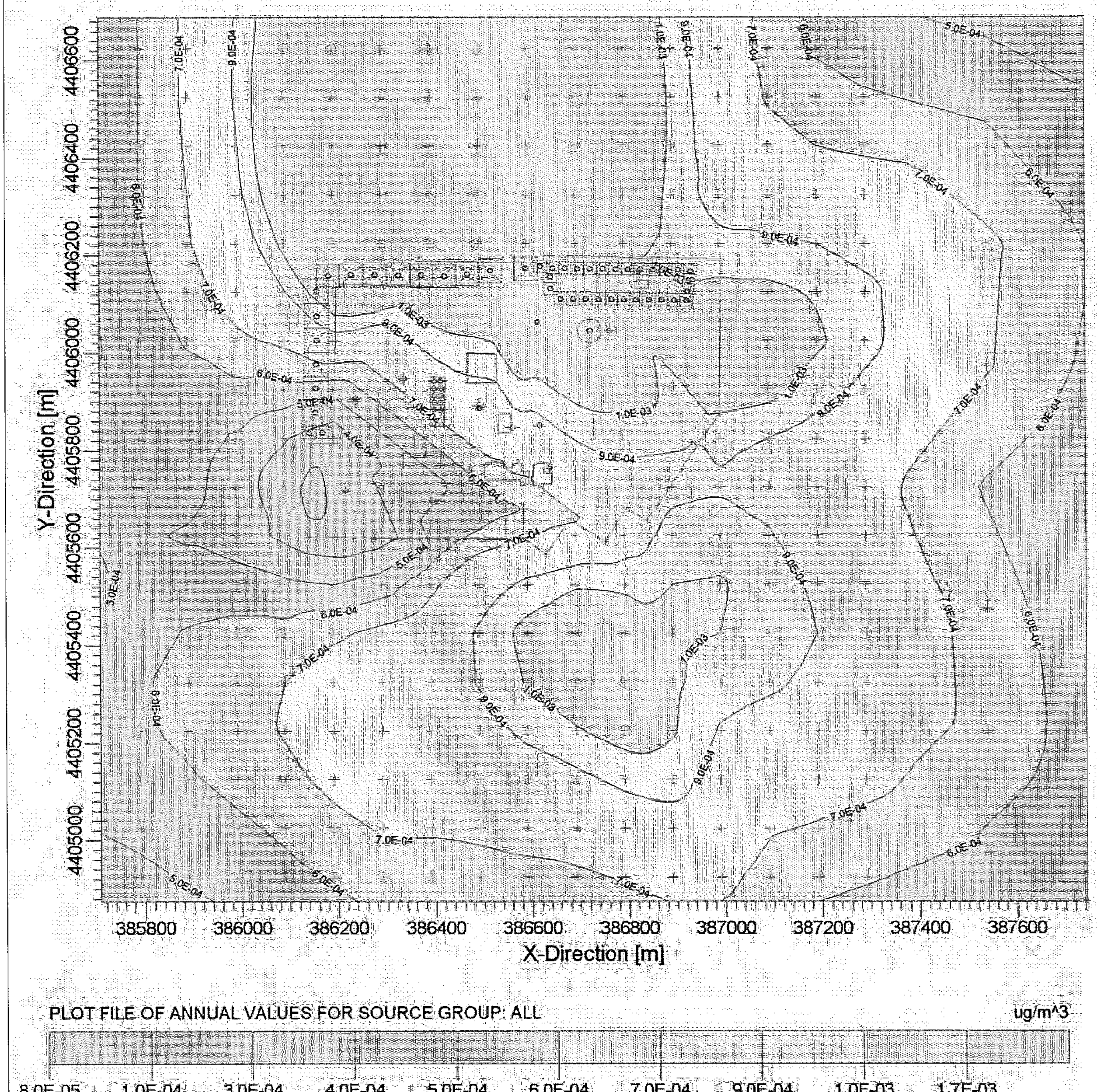
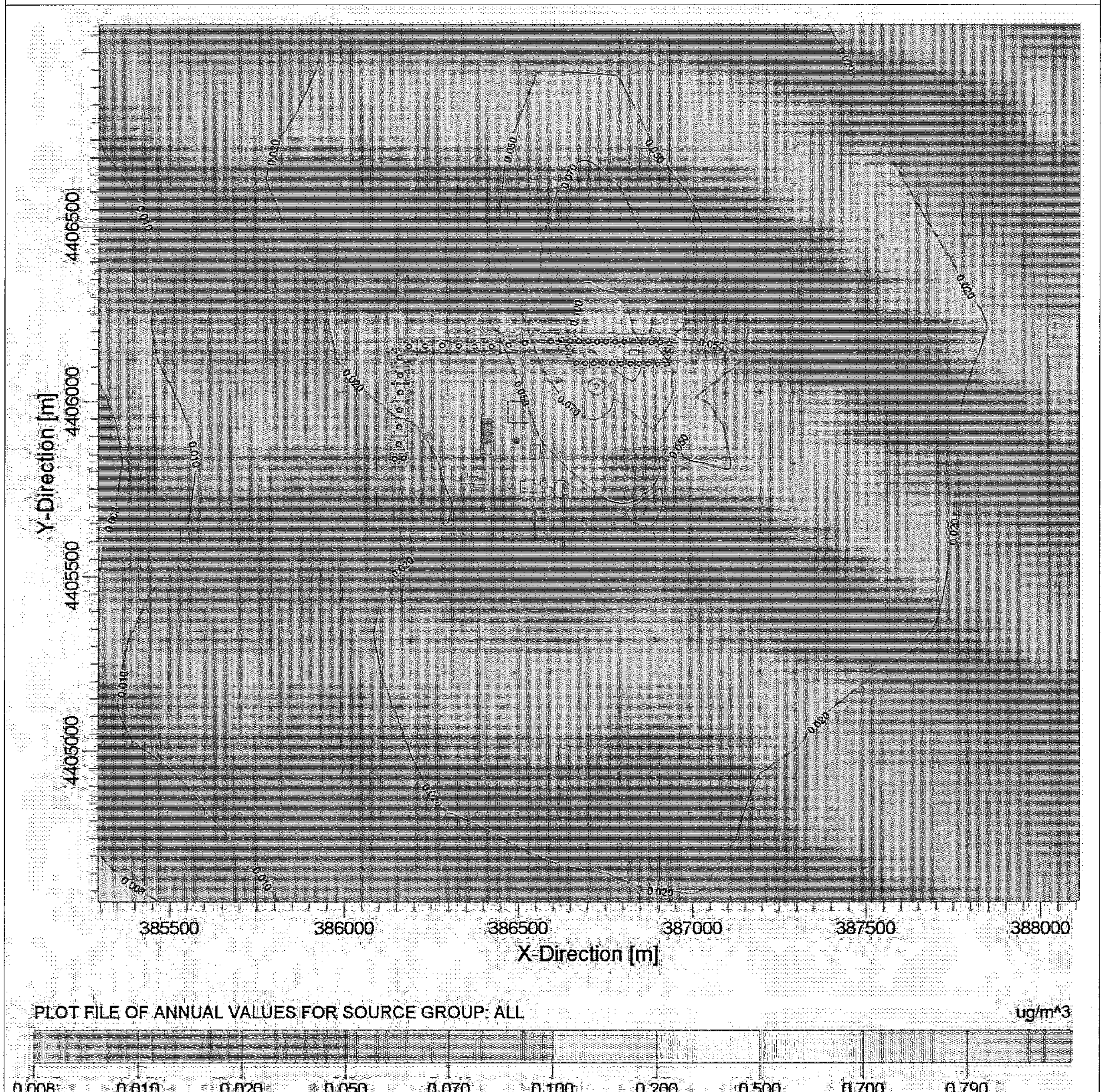
Figure 12. SO2 Annual Facility Depostion
Cronus Ammonia and Urea Plant



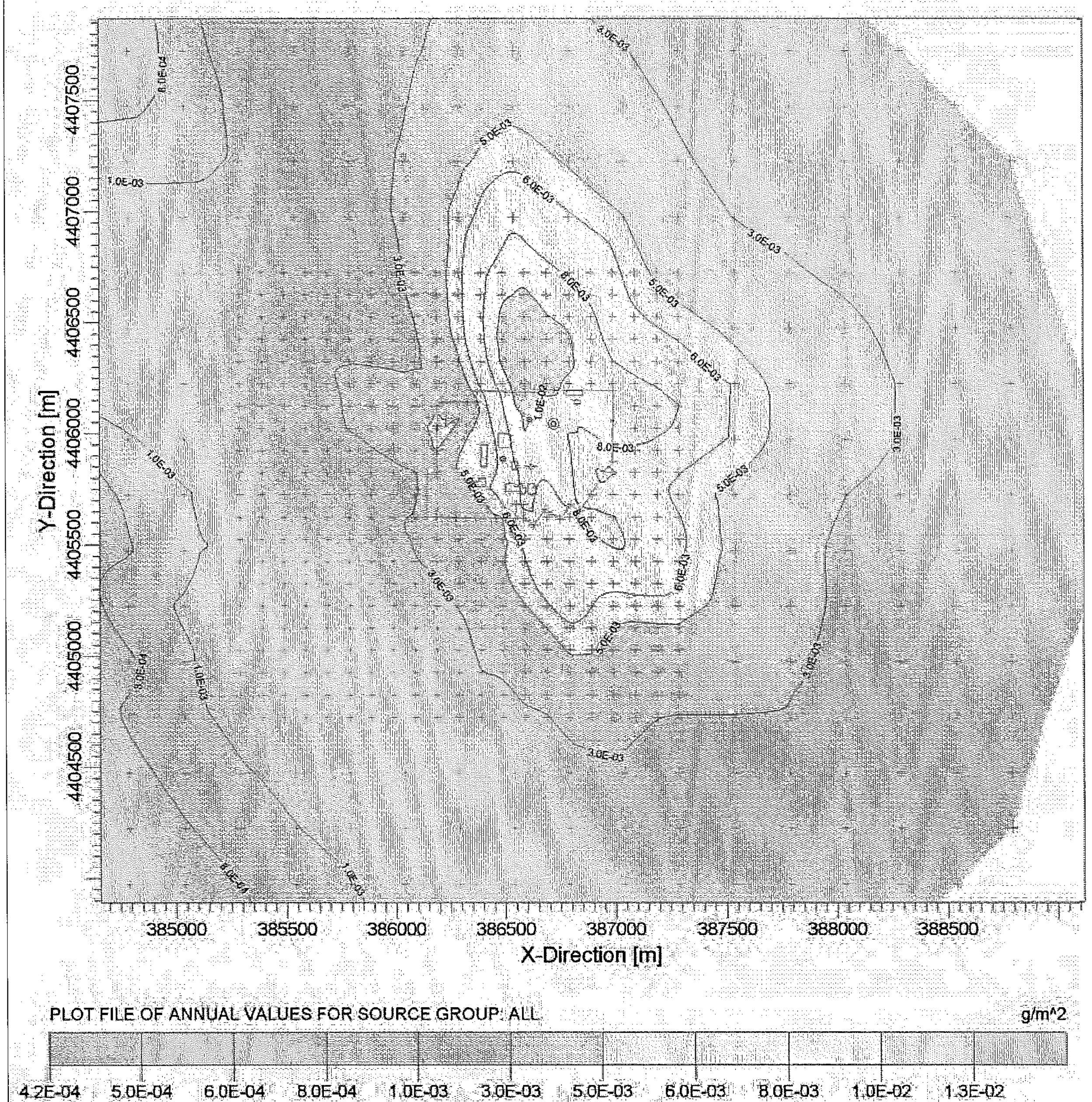
	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		**Cronus Chemicals, L.L.C.**	
	Total Depos.		SCALE: 1:12,784 0 — 0.4 km	
	0.00173	**ug/m^3**	**27/06/2014**	**084547**

Figure 13. NO2 Annual Facility Deposition
Cronus Ammonia and Urea Plant



	NONDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:17,697 0 — 0.5 km	
	0.1306	ug/m^3	27/06/2014	084547

Figure 14. Inorganic HAPs Annual Facility Deposition
Cronus Ammonia and Urea Plant



	REGDFAULT, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Total Depos.		SCALE: 1:28,035 0 0.5 km	
	0.01291	g/m^2	27/06/2014	

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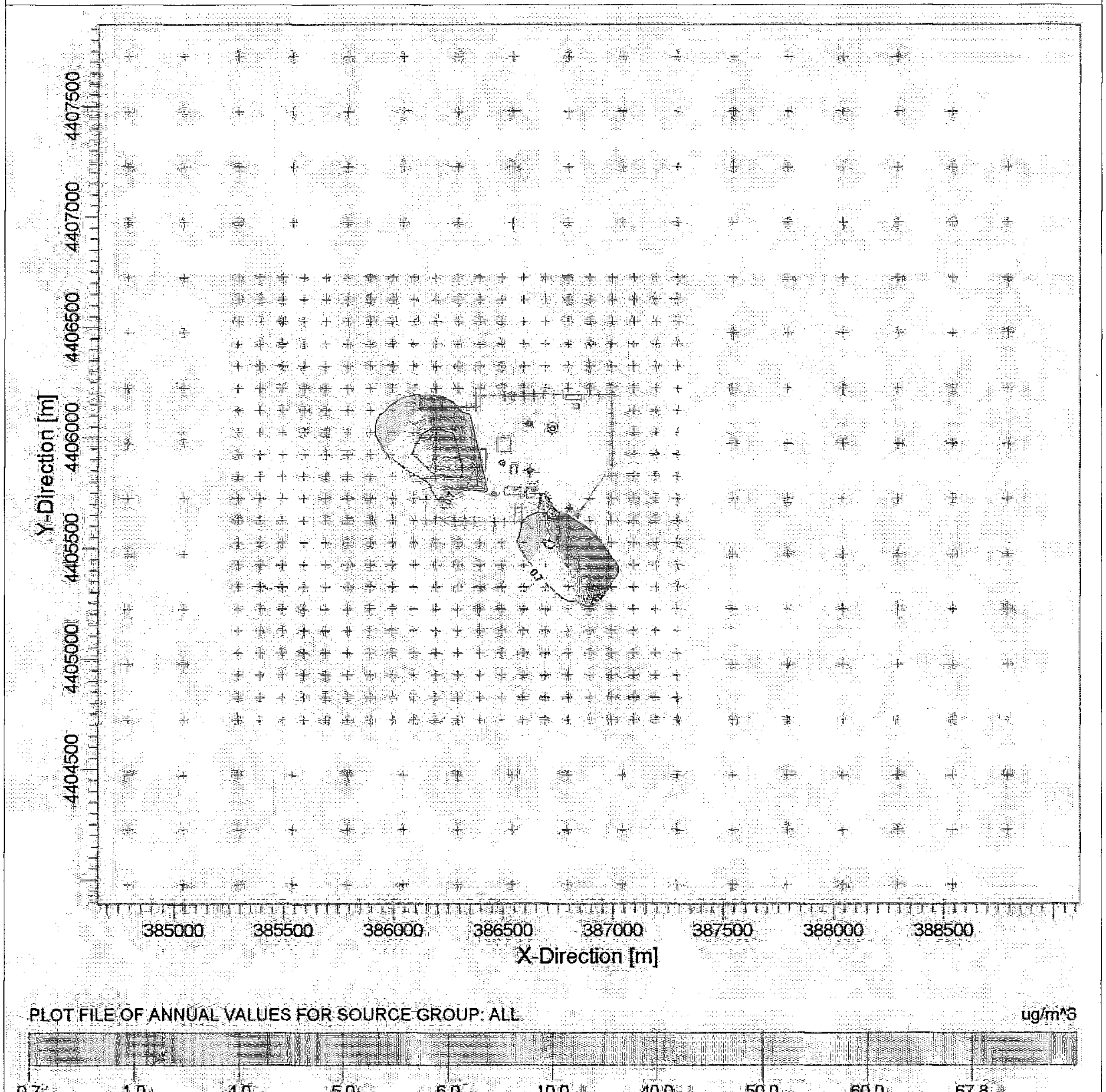
Figure 15. Organic HAPs Annual Facility Deposition
Cronus Ammonia and Urea Plant



	NONDFAULT, CONC, DEPOS, DDEP, WDEP, ELEV, DRYDPLT, WETDPLT		Cronus Chemicals, L.L.C.	
	Concentration		SCALE: 1:28,042 0 0.5 km	
	1.38494	ug/m^3	27/06/2014	084547

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Table 1
Input Parameters
Cronus Ammonia and Urea Plant

Point Sources															
Source ID	*Description*	*Source Type*	*X Coordinate (UTM)*	*Y Coordinate (UTM)*	*Release Height (m)*	*Gas Exit Temp (K)*	*Gas Exit Velocity (m/s)*	*Stack Inside Diameter (m)*	*CO Emission Rate (g/s)*	*NO2 1-Hr Emission Rate (g/s)*	*NO2 Annual Emission Rate (g/s)*	*PM2.5 24Hr Emission Rate (g/s)*	*PM2.5 Annual Emission Rate (g/s)*	*PM10 24Hr Emission Rate (g/s)*	*PM10 Annual Emission Rate (g/s)*
AES-02	Urea Granulator	POINT	386,637.66	4,405,764.64	89.92	308.15	26.08	3.81	0	0	0	3.109485	3.109485	3.109485	3.109485
AES-03	Primary Reformer	POINT	386,216.69	4,405,718.10	40.00	388.15	13.98	3.65	5.171367	1.310881	1.310881	0.901983	0.901983	0.901983	0.901983
AES-05	Start-up Heater	POINT	386,394.93	4,405,698.13	19.81	1173.15	10.69	2.03	0.475986	0	0	0.097805	0.097805	0.097166	0.097166
AES-07	Auxiliary Boiler 1	POINT	386,616.95	4,405,851.45	40.00	413.15	26.50	2.79	3.919018	2.177232	2.177232	0.111	0.111	0.816	0.816
AES-09	Emergency Generator 1	POINT	386,471.30	4,405,759.32	15.24	753.15	91.61	0.41	2.722178	0	0	0.077777	0.077777	0.077777	0.077777
AES-17	Emergency Generator 2	POINT	386,493.14	4,405,892.03	15.24	753.15	91.61	0.41	2.722178	0	0	0.077777	0.077777	0.077777	0.077777
AES-19	Emergency Generator 3	POINT	386400.18	4405942.00	15.24	753.15	91.61	0.41	2.722178	0	0	0.077777	0.077777	0.077777	0.077777
CT1	Cooling Tower Cell 1	POINT	386400.18	4405942.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT2	Cooling Tower Cell 2	POINT	386412.74	4405942.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT3	Cooling Tower Cell 3	POINT	386399.83	4405927.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT4	Cooling Tower Cell 4	POINT	386412.74	4405928.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT5	Cooling Tower Cell 5	POINT	386399.61	4405913.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT6	Cooling Tower Cell 6	POINT	386412.45	4405913.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT7	Cooling Tower Cell 7	POINT	386399.30	4405898.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT8	Cooling Tower Cell 8	POINT	386412.15	4405898.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT9	Cooling Tower Cell 9	POINT	386399.46	4405884.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
CT10	Cooling Tower Cell 10	POINT	386412.39	4405883.00	19.81	311.15	7.00	10.16	0	0	0	0.007112	0.007112	0.007112	0.007112
AES-11	Diesel Fire Pump	POINT	386,336.38	4,405,947.39	7.62	671.15	14.23271	0.13	0.27042	0	0	0.007726	0.007726	0.007726	0.007726
AES-12	Granulated Urea Loading Filter	POINT	386,822.97	4,406,165.83	30.48	294.15	0.492283	0.71	0	0	0	0.026998	0.026998	0.026998	0.026998
AES-13	Ammonia Front-End Flare	POINT	386,238.95	4,405,906.63	39.93	1273.15	20.00	2.32	37.27187	0.070388	0.070388	0	0	0	0
AES-14	Ammonia Back-End Flare	POINT	386,238.83	4,405,898.65	39.93	1273.15	20.00	2.32	60.91235	0.070388	0.070388	0	0	0	0
AES-15	Ammonia Storage Flare	POINT	386,762.25	4,406,044.42	30.48	1273.15	20.00	0.78	0.043628	0.03512	0.03512	0	0	0	0

Table 1
Input Parameters
Cronus Ammonia and Urea Plant

Volume Sources															
Source ID	*Description*	*Source Type*	*X Coordinate (UTM)*	*Y Coordinate (UTM)*	*Release Height (m)*	*Sigma Y*	*Sigma Z*	*CO Emission Rate (g/s)*	*NO2 1-Hr Emission Rate (g/s)*	*NO2 Annual Emission Rate (g/s)*	*PM2.5 24Hr Emission Rate (g/s)*	*PM2.5 Annual Emission Rate (g/s)*	*PM10 24Hr Emission Rate (g/s)*	*PM10 Annual Emission Rate (g/s)*
RD1	Haul Road	VOLUME	386141.776	4405836.082	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD2	Haul Road	VOLUME	386169.141	4405837.441	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD3	Haul Road	VOLUME	386154.896	4405877.726	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD4	Haul Road	VOLUME	386156.072	4405927.806	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD5	Haul Road	VOLUME	386157.102	4405976.746	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD6	Haul Road	VOLUME	386158.151	4406026.857	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD7	Haul Road	VOLUME	386157.924	4406075.707	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD8	Haul Road	VOLUME	386157.833	4406126.701	3.498	11.628	3.254	0	0	0	0.000022	0.000022	0.000182	0.000182
RD9	Haul Road	VOLUME	386230.21	4406160.596	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD10	Haul Road	VOLUME	386278.068	4406160.84	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD11	Haul Road	VOLUME	386325.746	4406160.008	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD12	Haul Road	VOLUME	386373.636	4406159.102	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD13	Haul Road	VOLUME	386421.475	4406157.953	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD14	Haul Road	VOLUME	386469.01	4406162.307	3.498	11.163	3.254	0	0	0	0.000079	0.000079	0.000648	0.000648
RD15	Haul Road	VOLUME	386516.236	4406168.671	3.498	11.163	3.254	0	0	0	0.000043	0.000043	0.000351	0.000351
RD16	Haul Road	VOLUME	386590.04	4406173.329	3.498	11.163	3.254	0	0	0	0.000043	0.000043	0.000351	0.000351
RD17	Haul Road	VOLUME	386619.867	4406177.753	3.498	6.047	3.254	0	0	0	0.000043	0.000043	0.000351	0.000351
RD18	Haul Road	VOLUME	386645.807	4406173.455	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD19	Haul Road	VOLUME	386671.725	4406173.266	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD20	Haul Road	VOLUME	386697.574	4406172.819	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD21	Haul Road	VOLUME	386723.526	4406172.527	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD22	Haul Road	VOLUME	386749.486	4406172.217	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD23	Haul Road	VOLUME	386775.432	4406171.879	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD24	Haul Road	VOLUME	386801.397	4406171.545	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD25	Haul Road	VOLUME	386827.339	4406171.292	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD26	Haul Road	VOLUME	386853.272	4406170.899	3.498	6.047	3.254	0	0	0	0.000012	0.000012	0.000095	0.000095
RD27	Haul Road	VOLUME	386879.188	4406170.696	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD28	Haul Road	VOLUME	386905.093	4406170.23	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD29	Haul Road	VOLUME	386930.842	4406167.348	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD30	Haul Road	VOLUME	386926.507	4406147.912	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD31	Haul Road	VOLUME	386925.135	4406126.31	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD32	Haul Road	VOLUME	386922.862	4406108.078	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD33	Haul Road	VOLUME	386896.859	4406108.144	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD34	Haul Road	VOLUME	386870.843	4406108.486	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD35	Haul Road	VOLUME	386844.84	4406108.836	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD36	Haul Road	VOLUME	386818.866	4406109.14	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257

Table 1
Input Parameters
Cronus Ammonia and Urea Plant

RD37	Haul Road	VOLUME	386792.886	4406109.445	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD38	Haul Road	VOLUME	386766.902	4406109.782	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD39	Haul Road	VOLUME	386740.924	4406110.091	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
Volume Sources														
Source ID	***Description***	***Source Type***	***X Coordinate (UTM)***	***Y Coordinate (UTM)***	***Release Height (m)***	***Sigma Y***	***Sigma Z***	***CO Emission Rate (g/s)***	***NO2 1-Hr Emission Rate (g/s)***	***NO2 Annual Emission Rate (g/s)***	***PM2.5 24Hr Emission Rate (g/s)***	***PM2.5 Annual Emission Rate (g/s)***	***PM10 24Hr Emission Rate (g/s)***	***PM10 Annual Emission Rate (g/s)***
RD40	Haul Road	VOLUME	386714.933	4406110.415	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD41	Haul Road	VOLUME	386688.954	4406110.73	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD42	Haul Road	VOLUME	386662.955	4406111.037	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD43	Haul Road	VOLUME	386639.592	4406156.839	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000257	0.000257
RD44	Haul Road	VOLUME	386641.253	4406131.027	3.498	6.047	3.254	0	0	0	0.000032	0.000032	0.000857	0.000857
RD51	Haul Road	VOLUME	386182.326	4406158.19	3.498	11.163	3.254	0	0	0	0.000058	0.000058	0.000475	0.000475

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Carbon Monoxide									
Source ID	*Source Type*	*X Coordinate UTM*	*Y Coordinate UTM*	*Base Elevation m*	*Height m*	*Diam m*	*Velocity m/s*	*Temperature K*	*Emission_Rate g/s*
1	POINT	384412.00	4406252.00	207.65	57.91	5.11	12.17	480.4	6.53
2	POINT	384405.00	4406191.00	207.64	6.1	0.3	25.87	750.4	2.90
3	POINT	384653.00	4405844.00	209.68	26.82	1.68	0.97	672	0.20
4	POINT	384653.00	4405844.00	209.68	14.94	0.58	10.69	327.6	0.38
5	POINT	383691.00	4405376.00	202.51	10.67	0.91	11.94	616.5	1.89
6	POINT	383683.00	4405407.00	202.47	10.36	0.51	26.67	660.9	0.89
7	POINT	383671.00	4405406.00	202.37	10.36	0.51	26.67	660.9	0.89
8	POINT	383642.00	4405376.00	202.18	13.72	0.6	26.77	660.9	0.89
9	POINT	383650.00	4405376.00	202.22	13.72	0.6	26.77	660.9	0.89
10	POINT	383661.00	4405376.00	202.28	13.72	0.5	26.78	660.9	0.89
11	POINT	383672.00	4405376.00	202.36	12.5	0.5	26.78	672	2.02
12	POINT	383683.00	4405376.00	202.44	12.5	0.5	26.78	672	2.02
13	POINT	383486.00	4405420.00	201.77	14.33	0.75	26.72	672	2.36
14	POINT	383475.00	4405420.00	201.76	14.33	0.75	26.72	672	2.36
15	POINT	383463.00	4405420.00	201.75	14.33	0.75	26.72	672	2.36
16	POINT	386593.00	4405358.00	207.58	8.53	0.61	25.87	672	2.02
17	POINT	386591.00	4405319.00	207.53	8.53	0.61	25.87	672	1.50
18	POINT	386591.00	4405329.00	207.54	8.53	0.61	25.87	672	1.50
19	POINT	386591.00	4405338.00	207.55	8.53	0.61	25.87	672	1.50
20	POINT	386590.00	4405349.00	207.57	8.53	0.61	25.87	672	1.50
21	POINT	385418.00	4406021.00	210.87	7.01	0.23	18.4	366.5	0.20
22	POINT	385418.00	4406021.00	210.87	7.32	0.15	12.94	322	33.46
23	POINT	385418.00	4406021.00	210.87	14.94	0.61	8.01	358.7	1.12
24	POINT	385337.00	4405737.00	211.84	17.07	0.52	14.75	469.3	0.09
25	POINT	383872.00	4405727.00	203.06	14.94	2.65	6.12	884.8	12.35
26	POINT	383872.00	4405727.00	203.06	21.03	0.94	26.25	562	0.11

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Particulate Matter									
Source ID	*Source Type*	*X Coordinate UTM*	*Y Coordinate UTM*	*Base Elevation m*	*Height m*	*Diam m*	*Velocity m/s*	*Temperature K*	*Emission_Rate g/s*
521	POINT	384412.00	4406252.00	207.65	57.91	5.11	8.3	458.2	2.89
522	POINT	384405.00	4406191.00	207.64	6.1	0.3	25.87	750.4	0.02
523	POINT	384334.00	4406157.00	207.38	9.14	4.33	9.05	302.6	0.45
524	POINT	384424.00	4406254.00	207.69	12.19	0.45	26.58	446.5	0.21
544	POINT	384653.00	4405844.00	209.68	15.24	0.3	25.87	305.4	0.32
545	POINT	384653.00	4405844.00	209.68	14.94	3.93	0.19	358.7	1.39
546	POINT	383691.00	4405376.00	202.51	10.67	0.91	11.94	616.5	0.08
547	POINT	383683.00	4405407.00	202.47	10.36	0.51	26.67	660.9	0.09
548	POINT	383671.00	4405406.00	202.37	10.36	0.51	26.67	660.9	0.09
549	POINT	383642.00	4405376.00	202.18	13.72	0.6	26.77	660.9	0.09
550	POINT	383650.00	4405376.00	202.22	13.72	0.6	26.77	660.9	0.09
551	POINT	383661.00	4405376.00	202.28	13.72	0.5	26.78	660.9	0.09
552	POINT	383672.00	4405376.00	202.36	12.5	0.5	26.78	672	0.11
553	POINT	383683.00	4405376.00	202.44	12.5	0.5	26.78	672	0.11
554	POINT	383486.00	4405420.00	201.77	14.33	0.75	26.72	672	0.13
555	POINT	383475.00	4405420.00	201.76	14.33	0.75	26.72	672	0.13
556	POINT	383463.00	4405420.00	201.75	14.33	0.75	26.72	672	0.13
557	POINT	388894.00	4405812.00	200.5	9.14	1.86	11.37	298.2	0.02
558	POINT	388894.00	4405812.00	200.5	9.14	0.61	11.48	294.3	0.20
559	POINT	388894.00	4405812.00	200.5	74.68	1.23	16.57	297.6	0.09
560	POINT	388894.00	4405812.00	200.5	11.89	0.35	2.31	298.2	0.33
562	POINT	386593.00	4405358.00	207.58	8.53	0.61	25.87	672	0.17
563	POINT	386591.00	4405319.00	207.53	8.53	0.61	25.87	672	0.13
564	POINT	386591.00	4405329.00	207.54	8.53	0.61	25.87	672	0.13
565	POINT	386591.00	4405338.00	207.55	8.53	0.61	25.87	672	0.13
566	POINT	386590.00	4405349.00	207.57	8.53	0.61	25.87	672	0.13
567	POINT	385418.00	4406021.00	210.87	7.01	0.23	18.4	310.9	0.44
568	POINT	385418.00	4406021.00	210.87	12.19	0.1	5.94	294.3	0.08
569	POINT	385418.00	4406021.00	210.87	7.32	0.15	10.35	310.9	0.09
570	POINT	385418.00	4406021.00	210.87	3.05	0.47	13.34	358.7	0.14
571	POINT	385418.00	4406021.00	210.87	3.05	0.23	0.06	310.9	0.30

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Sulfur Dioxide									
Source ID	*Source Type*	*X Coordinate UTM*	*Y Coordinate UTM*	*Base Elevation m*	*Height m*	*Diam m*	*Velocity m/s*	*Temperature K*	*Emission_Rate g/s*
1	POINT	384412.00	4406252.00	207.65	57.91	5.11	8.3	458.2	490.21
2	POINT	384405.00	4406191.00	207.64	6.1	0.3	25.87	750.4	0.11

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Nitrogen Dioxide									
Source ID	*Source Type*	*X Coordinate*	*Y Coordinate*	*Base Elevation*	*Height*	*Diam*	*Velocity*	*Temperature*	*Emission_Rate*
		UTM	*UTM*	*m*	*m*	*m*	*m/s*	*K*	*g/s*
185	POINT	384412.00	4406252.00	207.65	57.91	5.11	8.3	458.2	82.03
186	POINT	384405.00	4406191.00	207.64	6.1	0.3	25.87	750.4	0.69
191	POINT	384653.00	4405844.00	209.68	26.82	1.68	0.88	613.2	0.30
192	POINT	384653.00	4405844.00	209.68	14.94	0.58	10.69	327.6	0.07
193	POINT	383691.00	4405376.00	202.51	10.67	0.91	11.94	616.5	5.04
194	POINT	383683.00	4405407.00	202.47	10.36	0.51	26.67	660.9	7.33
195	POINT	383671.00	4405406.00	202.37	10.36	0.51	26.67	660.9	7.33
196	POINT	383642.00	4405376.00	202.18	13.72	0.6	26.77	660.9	11.09
197	POINT	383650.00	4405376.00	202.22	13.72	0.6	26.77	660.9	11.09
198	POINT	383661.00	4405376.00	202.28	13.72	0.5	26.78	660.9	11.09
199	POINT	383672.00	4405376.00	202.36	12.5	0.5	26.78	672	18.71
200	POINT	383683.00	4405376.00	202.44	12.5	0.5	26.78	672	18.71
201	POINT	383486.00	4405420.00	201.77	14.33	0.75	26.72	672	2.83
202	POINT	383475.00	4405420.00	201.76	14.33	0.75	26.72	672	2.83
203	POINT	383463.00	4405420.00	201.75	14.33	0.75	26.72	672	2.83
204	POINT	386593.00	4405358.00	207.58	8.53	0.61	25.87	672	18.71
205	POINT	386591.00	4405319.00	207.53	8.53	0.61	25.87	672	13.86
206	POINT	386591.00	4405329.00	207.54	8.53	0.61	25.87	672	13.86
207	POINT	386591.00	4405338.00	207.55	8.53	0.61	25.87	672	13.86
208	POINT	386590.00	4405349.00	207.57	8.53	0.61	25.87	672	13.86
209	POINT	385418.00	4406021.00	210.87	7.32	0.15	10.35	310.9	0.10
210	POINT	385337.00	4405737.00	211.84	17.07	0.52	12.83	469.3	0.34
211	POINT	383872.00	4405727.00	203.06	14.94	2.65	6.12	884.8	0.06

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Metal HAPs									
Source ID	*Source Type*	*X Coordinate*	*Y Coordinate*	*Base Elevation*	*Height*	*Diam*	*Velocity*	*Temperature*	*Emission_Rate*
		UTM	*UTM*	*m*	*m*	*m*	*m/s*	*K*	*g/s*
521	POINT	384412.00	4406252.00	207.65	57.91	5.11	8.3	458.2	1.00
522	POINT	384405.00	4406191.00	207.64	6.1	0.3	25.87	750.4	1.00
523	POINT	384334.00	4406157.00	207.38	9.14	4.33	9.05	302.6	1.00
524	POINT	384424.00	4406254.00	207.69	12.19	0.45	26.58	446.5	1.00
544	POINT	384653.00	4405844.00	209.68	15.24	0.3	25.87	305.4	1.00
545	POINT	384653.00	4405844.00	209.68	14.94	3.93	0.19	358.7	1.00
546	POINT	383691.00	4405376.00	202.51	10.67	0.91	11.94	616.5	1.00
547	POINT	383683.00	4405407.00	202.47	10.36	0.51	26.67	660.9	1.00
548	POINT	383671.00	4405406.00	202.37	10.36	0.51	26.67	660.9	1.00
549	POINT	383642.00	4405376.00	202.18	13.72	0.6	26.77	660.9	1.00
550	POINT	383650.00	4405376.00	202.22	13.72	0.6	26.77	660.9	1.00
551	POINT	383661.00	4405376.00	202.28	13.72	0.5	26.78	660.9	1.00
552	POINT	383672.00	4405376.00	202.36	12.5	0.5	26.78	672	1.00
553	POINT	383683.00	4405376.00	202.44	12.5	0.5	26.78	672	1.00
554	POINT	383486.00	4405420.00	201.77	14.33	0.75	26.72	672	1.00
555	POINT	383475.00	4405420.00	201.76	14.33	0.75	26.72	672	1.00
556	POINT	383463.00	4405420.00	201.75	14.33	0.75	26.72	672	1.00
557	POINT	388894.00	4405812.00	200.5	9.14	1.86	11.37	298.2	1.00
558	POINT	388894.00	4405812.00	200.5	9.14	0.61	11.48	294.3	1.00
559	POINT	388894.00	4405812.00	200.5	74.68	1.23	16.57	297.6	1.00
560	POINT	388894.00	4405812.00	200.5	11.89	0.35	2.31	298.2	1.00
562	POINT	386593.00	4405358.00	207.58	8.53	0.61	25.87	672	1.00
563	POINT	386591.00	4405319.00	207.53	8.53	0.61	25.87	672	1.00
564	POINT	386591.00	4405329.00	207.54	8.53	0.61	25.87	672	1.00
565	POINT	386591.00	4405338.00	207.55	8.53	0.61	25.87	672	1.00
566	POINT	386590.00	4405349.00	207.57	8.53	0.61	25.87	672	1.00
567	POINT	385418.00	4406021.00	210.87	7.01	0.23	18.4	310.9	1.00
568	POINT	385418.00	4406021.00	210.87	12.19	0.1	5.94	294.3	1.00
569	POINT	385418.00	4406021.00	210.87	7.32	0.15	10.35	310.9	1.00
570	POINT	385418.00	4406021.00	210.87	3.05	0.47	13.34	358.7	1.00
571	POINT	385418.00	4406021.00	210.87	3.05	0.23	0.06	310.9	1.00

Table 2
Surrounding Sources
Cronus Ammonia and Urea Plant

Organic HAPs									
Source ID	*Source Type*	*X Coordinate*	*Y Coordinate*	*Base Elevation*	*Height*	*Diam*	*Velocity*	*Temperature*	*Emission_Rate*
		UTM	*UTM*	*m*	*m*	*m*	*m/s*	*K*	*g/s*
521	POINT	384412.00	4406252.00	0	57.91	5.11	8.3	458.2	1.00
522	POINT	384405.00	4406191.00	0	6.1	0.3	25.87	750.4	1.00
523	POINT	384334.00	4406157.00	0	9.14	4.33	9.05	302.6	1.00
524	POINT	384424.00	4406254.00	0	12.19	0.45	26.58	446.5	1.00
544	POINT	384653.00	4405844.00	0	15.24	0.3	25.87	305.4	1.00
545	POINT	384653.00	4405844.00	0	14.94	3.93	0.19	358.7	1.00
546	POINT	383691.00	4405376.00	0	10.67	0.91	11.94	616.5	1.00
547	POINT	383683.00	4405407.00	0	10.36	0.51	26.67	660.9	1.00
548	POINT	383671.00	4405406.00	0	10.36	0.51	26.67	660.9	1.00
549	POINT	383642.00	4405376.00	0	13.72	0.6	26.77	660.9	1.00
550	POINT	383650.00	4405376.00	0	13.72	0.6	26.77	660.9	1.00
551	POINT	383661.00	4405376.00	0	13.72	0.5	26.78	660.9	1.00
552	POINT	383672.00	4405376.00	0	12.5	0.5	26.78	672	1.00
553	POINT	383683.00	4405376.00	0	12.5	0.5	26.78	672	1.00
554	POINT	383486.00	4405420.00	0	14.33	0.75	26.72	672	1.00
555	POINT	383475.00	4405420.00	0	14.33	0.75	26.72	672	1.00
556	POINT	383463.00	4405420.00	0	14.33	0.75	26.72	672	1.00
557	POINT	388894.00	4405812.00	0	9.14	1.86	11.37	298.2	1.00
558	POINT	388894.00	4405812.00	0	9.14	0.61	11.48	294.3	1.00
559	POINT	388894.00	4405812.00	0	74.68	1.23	16.57	297.6	1.00
560	POINT	388894.00	4405812.00	0	11.89	0.35	2.31	298.2	1.00
562	POINT	386593.00	4405358.00	0	8.53	0.61	25.87	672	1.00
563	POINT	386591.00	4405319.00	0	8.53	0.61	25.87	672	1.00
564	POINT	386591.00	4405329.00	0	8.53	0.61	25.87	672	1.00
565	POINT	386591.00	4405338.00	0	8.53	0.61	25.87	672	1.00
566	POINT	386590.00	4405349.00	0	8.53	0.61	25.87	672	1.00
567	POINT	385418.00	4406021.00	0	7.01	0.23	18.4	310.9	1.00
568	POINT	385418.00	4406021.00	0	12.19	0.1	5.94	294.3	1.00
569	POINT	385418.00	4406021.00	0	7.32	0.15	10.35	310.9	1.00
570	POINT	385418.00	4406021.00	0	3.05	0.47	13.34	358.7	1.00
571	POINT	385418.00	4406021.00	0	3.05	0.23	0.06	310.9	1.00

Table 3
Particle Size Distribution
Cronus Ammonia and Urea Plant

Source Group	*Particle Diameter µg*	*Mass Fraction*	*Particle Density g/cm³*
Urea Granulator	2.5	1	1
Primary Reformer[1]	1	0.82	1
	2	0.06	1
	2.5	0.02	1
	4	0.02	1
	5	0.01	1
	10	0.07	1
Start Up Heater[1]	1	0.82	1
	2	0.06	1
	2.5	0.02	1
	4	0.02	1
	5	0.01	1
	10	0.07	1
Auxiliary Boiler 1[1]	1	0.82	1
	2	0.06	1
	2.5	0.02	1
	4	0.02	1
	5	0.01	1
	10	0.07	1
Emergency Generators[1]	1	0.82	1
	2	0.06	1
	2.5	0.02	1
	4	0.02	1
	5	0.01	1
	10	0.07	1
Fire Pump[1]	1	0.82	1
	2	0.06	1
	2.5	0.02	1
	4	0.02	1
	5	0.01	1
	10	0.07	1
Loading Filter[3]	2.5	0.99	1
	6	0.005	1
	10	0.005	1
Cooling Towers[4]	2.5	0.2	1
	6	0.6	1
	10	0.2	1

Table 3
Particle Size Distribution
Cronus Ammonia and Urea Plant

Source Group	*Particle Diameter µg*	*Mass Fraction*	*Particle Density g/cm³*
Road Sources	1	0.04	1
	2	0.07	1
	2.5	0.04	1
	3	0.03	1
	4	0.07	1
	5	0.05	1
	6	0.04	1
	10	0.17	1
	14	0.163	1
	15	0.038	1
	16	0.048	1
	17	0.067	1
	17.5	0.029	1
	18	0.038	1
	19	0.067	1
	20	0.038	1
Surrounding Sources[2]	8.1	0.104	1
	12.5	0.105	1
	15	0.128	1
	0.7	0.3	1
	1.1	0.082	1
	2	0.105	1
	3.6	0.103	1
	5.5	0.073	1

[1] Particle distribution for the combustion of mixed fuels taken from Table B.2.2 of AP-42 Appendix B.2 "Generalized Particle Size Distributions"

[2] Generalized particle size distribution taken from Table 3-1 of "Screening Level Ecological Risk Assessment Protocol"

[3] Particle distribution for fabric filters taken from Table B.2-3 of AP-42 Appendix B.2 "Generalized Particle Size Distributions"

[4] Particle distribution spray towers taken from Table B.2-3 of AP-42 Appendix B.2 "Generalized Particle Size Distributions"

[4] Particle distribution road dust taken from AP-42 Appendix B.2 "Generalized Particle Size Distributions"

Attachment A

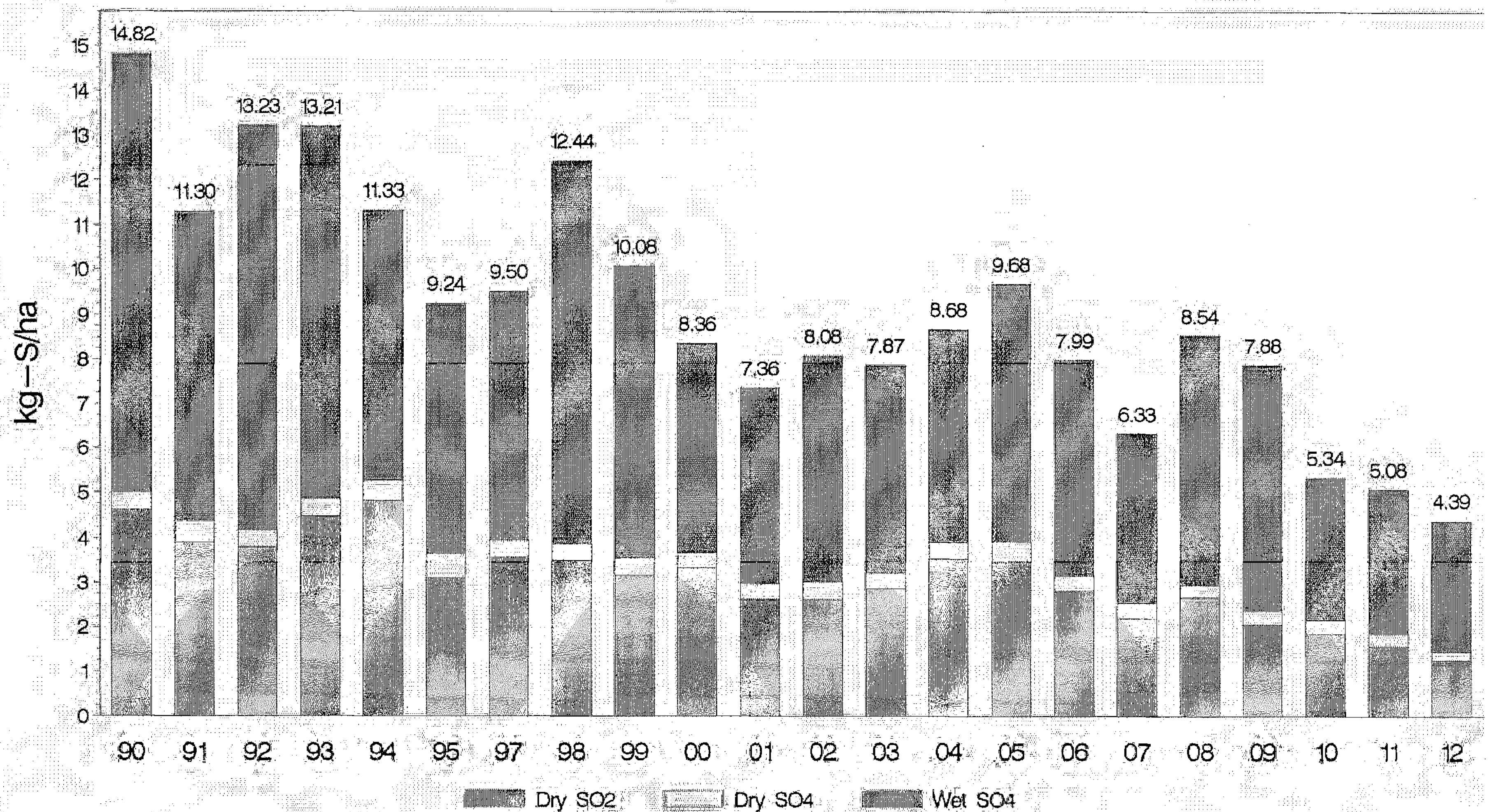
AERMOD Input and Output Files (CD)

Appendix C

Nitrogen and Sulfur Background Levels

Total S Deposition

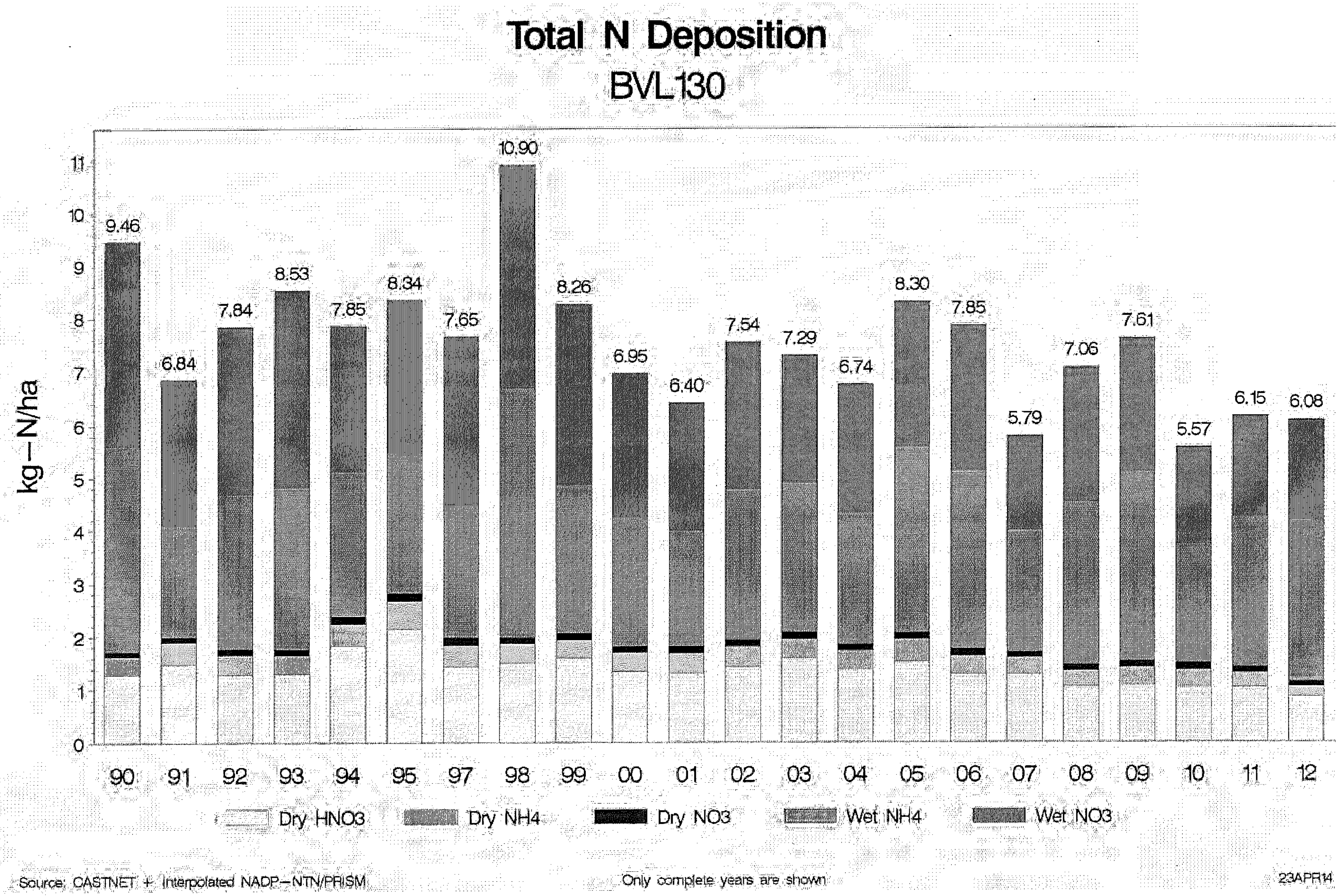
BVL130



Source: CASTNET + Interpolated NADP—NTN/PRISM

Only complete years are shown

23APR14


Total N Deposition
BVL130
kg−N/ha
0
1
2
3
4
5
6
7
8
9
10
11
9.46
6.84
7.84
8.53
7.85
8.34
7.65
10.90
8.26
6.95
6.40
7.54
7.29
6.74
8.30
7.85
5.79
7.06
7.61
5.57
6.15
6.08
90
91
92
93
94
95
97
98
99
00
01
02
03
04
05
06
07
08
09
10
11
12
Dry HNO3
Dry NH4
Dry NO3
Wet NH4
Wet NO3
Source: CASTNET + Interpolated NADP−NTN/PRISM
Only complete years are shown
23APR14

Appendix D

HAP Emissions from the Facility

Appendix D

HAP Emissions from the Facility

Emission Unit	***Proposed Limited Facility Totals***
Pollutant	***TPY***
1,3-Butadiene	0.002
Acetaldehyde	0.17
Acrolein	0.03
Arsenic	0.001
Benzene	0.06
Beryllium	0.000
Cadmium	0.004
Chromium	0.01
Cobalt	0.000
Ethylbenzene	0.13
Formaldehyde	4.68
Hexane	6.69
Manganese	0.001
Mercury	0.001
Methanol	2.58
Naphthalene	0.01
Nickel	0.01
PAH	0.01
Propylene Oxide	0.12
Selenium	0.0001
Toluene	0.56
Xylenes	0.27
Total HAPs	15.33

Appendix E

HAP Emissions (Soil)

APPENDIX E
SOIL CONCENTRATIONS
ARSENIC

Cs		0.00004	mg/kg soil	Highest soil concentration at year 100
		0.04	ug/kg soil	
Ds		0.00003	mg/kg soil/year	Deposition per m^3 of soil
ks		0.68	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-14 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.58	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	29	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		9.43E-02	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0	yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		2.14E-05	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0	unitless	Fraction of air concentration in vapor phase (value from Table A-2-14 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
BERYLLIUM

Cs		0.00006	mg/kg soil	Highest soil concentration at year 100
		0.06	ug/kg soil	
Ds		0.000002	mg/kg soil/year	Deposition per m^3 of soil
ks		0.02	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-27 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.02	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	790	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		3.48E-03	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0	yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		1.28E-06	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0	unitless	Fraction of air concentration in vapor phase (value from Table A-2-27 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	μg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
CADMIUM

Cs		0.001 mg/kg soil 0.57 ug/kg soil	Highest soil concentration at year 100
Ds		0.0001 mg/kg soil/year	Deposition per m^3 of soil
ks		0.26 yr-1	COPC soil loss constant due to all processes
ksg		0 yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-35 of SLERA protocol)[1]
kse		0 yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.23 yr-1	COPC loss due to surface runoff
	RO	25.4 cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2 mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1 cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	75 mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5 g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		3.66E-02 yr-1	COPC loss due to leaching
	P	87.02 cm/yr	Average annual precipitation (NOAA)[3]
	I	10 cm/yr	Average annual irrigation (assumed)
	E_v	67.5 cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0 yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		1.18E-04 g/s	Highest target receptor total annual deposition from model
tD		100 yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0 unitless	Fraction of air concentration in vapor phase (value from Table A-2-35 SLERA protocol)[1]
Vdv		3 cm/s	Dry deposition velocity
Cyv		8.52E-02 µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00 s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02 s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03 s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
CHROMIUM

Cs		0.02	mg/kg soil	Highest soil concentration at year 100
		18.98	ug/kg soil	
Ds		0.0002	mg/kg soil/year	Deposition per m^3 of soil
ks		0.00001	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-52 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.00001	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	1800000	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		1.53E-06	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0	yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		1.49E-04	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0	unitless	Fraction of air concentration in vapor phase (value from Table A-2-52 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
COBALT

Cs		0.00003 mg/kg soil 0.03 ug/kg soil	Highest soil concentration at year 100
Ds		0.00001 mg/kg soil/year	Deposition per m^3 of soil
ks		0.44 yr-1	COPC soil loss constant due to all processes
ksg		0 yr-1	COPC loss due to biotic and abiotic degredation
kse		0 yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.38 yr-1	COPC loss due to surface runoff
	RO	25.4 cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2 mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1 cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	45 mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5 g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		6.09E-02 yr-1	COPC loss due to leaching
	P	87.02 cm/yr	Average annual precipitation (NOAA)[3]
	I	10 cm/yr	Average annual irrigation (assumed)
	E_v	67.5 cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0 yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		8.97E-06 g/s	Highest target receptor total annual deposition from model
tD		100 yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0 unitless	Fraction of air concentration in vapor phase
Vdv		3 cm/s	Dry deposition velocity
Cyv		8.52E-02 µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00 s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02 s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03 s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
MANGANESE

Cs		0.000002	mg/kg soil	Highest soil concentration at year 100
		0.002	ug/kg soil	
Ds		0.00005	mg/kg soil/year	Deposition per m^3 of soil
ks		25.12	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-145 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		21.62	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	0.65	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		3.51E+00	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0	yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		4.05E-05	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0	unitless	Fraction of air concentration in vapor phase (value from Table A-2-145 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
NICKEL

Cs		0.0009 mg/kg soil 0.94 ug/kg soil	Highest soil concentration at year 100
Ds		0.0003 mg/kg soil/year	Deposition per m^3 of soil
ks		0.30 yr-1	COPC soil loss constant due to all processes
ksg		0 yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-145 of SLERA protocol)[1]
kse		0 yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.26 yr-1	COPC loss due to surface runoff
	RO	25.4 cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2 mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1 cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	65 mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5 g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		4.22E-02 yr-1	COPC loss due to leaching
	P	87.02 cm/yr	Average annual precipitation (NOAA)[3]
	I	10 cm/yr	Average annual irrigation (assumed)
	E_v	67.5 cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0 yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		2.25E-04 g/s	Highest target receptor total annual deposition from model
tD		100 yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0 unitless	Fraction of air concentration in vapor phase (value from Table A-2-145 SLERA protocol)[1]
Vdv		3 cm/s	Dry deposition velocity
Cyv		8.52E-02 µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00 s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02 s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03 s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
SELENIUM

Cs		0.000001	mg/kg soil	Highest soil concentration at year 100
		0.001	ug/kg soil	
Ds		0.000003	mg/kg soil/year	Deposition per m^3 of soil
ks		3.83	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-172 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		3.30	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	5	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		5.35E-01	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0	yr-1	COPC loss constant due to volatilzation (No loss because compound is a metal)
Q		2.56E-06	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0	unitless	Fraction of air concentration in vapor phase (value from Table A-2-172 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
MERCURY

Cs		0.000004	mg/kg soil	Highest soil concentration at year 100
		0.004	ug/kg soil	
Ds		0.0001	mg/kg soil/year	Deposition per m^3 of soil
ks		16.29	yr-1	COPC soil loss constant due to all processes
ksg		0	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-131 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.02	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	1000	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		2.75E-03	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		16.26617785	yr-1	COPC loss constant due to volatilzation
	H	0.0071	$atm\text{-}m^3/mol$	Henry's Law Constant (From Appendix A-2-131 of SLERA Protocol)[1]
	R	0.00008205	$atm\text{-}m^3/mol\text{-}K$	Universal Gas Constant (From Table B-1-6 of SLERA Protocol)[1]
	T_a	298	K	Ambient air temperature (default value from Table B-1-6 of SLERA Protocol)[1]
	P_s	2.7	g/cm^3	Soil particle density (default value from Table B-1-6 of SLERA Protocol)[1]
	D_a	0.0109	cm^2/s	Diffusivity of COPC in air (From Appendix A-2-131 of SLERA Protocol)[1]
Q		2.78E-05	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
		8.16189		
F_v		1	unitless	Fraction of air concentration in vapor phase (value from Table A-2-131 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		8.52E-02	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.12E-02	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		7.91E-03	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
FORMALDEHYDE

Cs		1.05E-05	mg/kg soil	Highest soil concentration at year 100
		1.05E-02	ug/kg soil	
Ds		1.18E+01	mg/kg soil/year	Deposition per m^3 of soil
ks		1115260.39	yr-1	COPC soil loss constant due to all processes
ksg		36.1	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-106 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		106.14	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	2.62E-02	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		1.72E+01	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		1115100.932	yr-1	COPC loss constant due to volatilzation
	H	2.78E-04	atm-m^3/mol	Henry's Law Constant (From Appendix A-2-106 of SLERA Protocol)[1]
	R	8.21E-05	atm-m^3/mol-K	Universal Gas Constant (From Table B-1-6 of SLERA Protocol)[1]
	T_a	298	K	Ambient air temperature (default value from Table B-1-6 of SLERA Protocol)[1]
	P_s	2.7	g/cm^3	Soil particle density (default value from Table B-1-6 of SLERA Protocol)[1]
	D_a	5.00E-01	cm^2/s	Diffusivity of COPC in air (From Appendix A-2-106 of SLERA Protocol)[1]
Q		1.35E-01	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		1	unitless	Fraction of air concentration in vapor phase (value from Table A-2-106 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		1.38E+00	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.93E-01	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
METHANOL

Cs		2.38E-04	mg/kg soil	Highest soil concentration at year 100
		2.38E-01	ug/kg soil	
Ds		6.47E+00	mg/kg soil/year	Deposition per m^3 of soil
ks		27247.25	yr-1	COPC soil loss constant due to all processes
ksg		36.1	yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-133 of SLERA protocol)[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		26.32	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[2]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	0.51	mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		4.27E+00	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[3]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		27180.56398	yr-1	COPC loss constant due to volatilzation
	H	1.44E-04	$atm\text{-}m^3/mol$	Henry's Law Constant (From Appendix A-2-133 of SLERA Protocol)[1]
	R	8.21E-05	$atm\text{-}m^3/mol\text{-}K$	Universal Gas Constant (From Table B-1-6 of SLERA Protocol)[1]
	T_a	298	K	Ambient air temperature (default value from Table B-1-6 of SLERA Protocol)[1]
	P_s	2.7	g/cm^3	Soil particle density (default value from Table B-1-6 of SLERA Protocol)[1]
	D_a	4.58E-01	cm^2/s	Diffusivity of COPC in air (From Appendix A-2-133 of SLERA Protocol)[1]
Q		7.42E-02	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0.999	unitless	Fraction of air concentration in vapor phase (value from Table A-2-90 SLERA protocol)[1]
Vdv		3	cm/s	Dry deposition velocity
Cyv		1.38E+00	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.93E-01	s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
PAH (BENZO(A)PYRENE)

Cs		1.80E-02 mg/kg soil 1.80E+01 ug/kg soil	Highest soil concentration at year 100
Ds		8.62E-03 mg/kg soil/year	Deposition per m^3 of soil
ks		0.48 yr-1	COPC soil loss constant due to all processes
ksg		0.477 yr-1	COPC loss due to biotic and abiotic degredation (Table A-2-20 of SLERA protocol)[1]
kse		0 yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[1]
ksr		0.00 yr-1	COPC loss due to surface runoff
	RO	25.4 cm	Average annual surface runoff (USGS)[2]
	Θ_{sw}	0.2 mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[1]
	Zs	1 cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[1]
	Kd_s	9690 mL/g	Soil water partition coefficient (nuetral pH for each compound)[1]
	BD	1.5 g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[1]
ksl		2.83E-04 yr-1	COPC loss due to leaching
	P	87.02 cm/yr	Average annual precipitation (NOAA)[3]
	I	10 cm/yr	Average annual irrigation (assumed)
	E_v	67.5 cm/yr	Average annual evapotranspiration (USGS)[4]
ksv		0.000395312 yr-1	COPC loss constant due to volatilzation
	H	8.36E-07 atm-m^3/mol	Henry's Law Constant (From Appendix A-2-20 of SLERA Protocol)[1]
	R	8.21E-05 atm-m^3/mol-K	Universal Gas Constant (From Table B-1-6 of SLERA Protocol)[1]
	T_a	298 K	Ambient air temperature (default value from Table B-1-6 of SLERA Protocol)[1]
	P_s	2.7 g/cm^3	Soil particle density (default value from Table B-1-6 of SLERA Protocol)[1]
	D_a	2.18E-02 cm^2/s	Diffusivity of COPC in air (From Appendix A-2-20 of SLERA Protocol)[1]
Q		2.64E-04 g/s	Highest target receptor total annual deposition from model
tD		100 yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[1]
F_v		0.265 unitless	Fraction of air concentration in vapor phase (value from Table A-20- SLERA protocol)[1]
Vdv		3 cm/s	Dry deposition velocity
Cyv		1.38E+00 µg-s/g-m3	Unitized yearly average air concentration from vapor phase[5]
Dywv		0.00E+00 s/m2-yr	Unitized yearly average wet deposition from vapor phase[5]
Dydp		1.93E-01 s/m2-yr	Unitized yearly average dry deposition from particle phase[5]
Dywp		0.00E+00 s/m2-yr	Unitized yearly average wet deposition from particle phase[5]

[1] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[2] Average Annual Runoff in the United States, USGS, 1987.
[3] Annual Average Precipitation, Oregon Climate Service, December 1997.
[4] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[5] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E
SOIL CONCENTRATIONS
PROPYLENE OXIDE

Cs		4.19E-07	mg/kg soil	Highest soil concentration at year 100
		4.19E-04	ug/kg soil	
Ds		3.04E-01	mg/kg soil/year	Deposition per m^3 of soil
ks		724483.04	yr-1	COPC soil loss constant due to all processes
ksg		32.3	yr-1	COPC loss due to biotic and abiotic degredation[1]
kse		0	yr-1	COPC loss constant due to soil erosion (default value from Table B-1-2 of SLERA protocol)[2]
ksr		123.57	yr-1	COPC loss due to surface runoff
	RO	25.4	cm	Average annual surface runoff (USGS)[3]
	O_{sw}	0.2	mL/cm^3	Soil volumetric water content (default value from Table B-1-4 of SLERA protocol)[2]
	Zs	1	cm	Conservative assumption of non-tilled soils (default value from Table B-1-1 of SLERA protocol)[2]
	Kd_s	0.0037	mL/g	Soil water partition coefficient (nuetral pH for each compound)[2]
	BD	1.5	g/cm^3	Soil bulk density (default from Table B-1-1 of SLERA protocol)[2]
ksl		2.00E+01	yr-1	COPC loss due to leaching
	P	87.02	cm/yr	Average annual precipitation (NOAA)[4]
	I	10	cm/yr	Average annual irrigation (assumed)
	E_v	67.5	cm/yr	Average annual evapotranspiration (USGS)[5]
ksv		724307.1214	yr-1	COPC loss constant due to volatilization
	H	1.23E-04	$atm\text{-}m^3/mol$	Henry's Law Constant (From Appendix A-2-5 of SLERA Protocol)[2]
	R	8.21E-05	$atm\text{-}m^3/mol\text{-}K$	Universal Gas Constant[1]
	T_a	298	K	Ambient air temperature (default value from Table B-1-6 of SLERA Protocol)[2]
	P_s	2.7	g/cm^3	Soil particle density (default value from Table B-1-6 of SLERA Protocol)[2]
	D_a	1.04E-01	cm^2/s	Diffusivity of COPC in air[6]
Q		3.48E-03	g/s	Highest target receptor total annual deposition from model
tD		100	yr	Time period over which deposition occurs (default value from Table B-1-1 of SLERA protocol)[2]
F_v		1	unitless	Fraction of air concentration in vapor phase (value from Table A-2-5 SLERA protocol)[2]
Vdv		3	cm/s	Dry deposition velocity
Cyv		1.38E+00	µg-s/g-m3	Unitized yearly average air concentration from vapor phase[7]
Dywv		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from vapor phase[7]
Dydp		1.93E-01	s/m2-yr	Unitized yearly average dry deposition from particle phase[7]
Dywp		0.00E+00	s/m2-yr	Unitized yearly average wet deposition from particle phase[7]

[1] Screening Assessment for the Challenge, Environment Canada, October 2013.
[2] Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA, August 1999.
[3] Average Annual Runoff in the United States, USGS, 1987.
[4] Annual Average Precipitation, Oregon Climate Service, December 1997.
[5] Estimated Mean Annual Actual Evapotranspiration, In Centimeters, During the Period 1971-2000, USGS, February 2013.
[6] GSI Chemical Database, GSI Environmental, 2013.
[7] Appendix E, Unitized Annual Average Deposition for HAP Soil Concentration Calculations.

APPENDIX E

SOIL HAP CONCENTRATIONS AND ECOLOGICAL BENCHMARKS

HAP	*Maximum Soil Concentration (mg/kg)*	*USEPA Region 5 ESL (mg/kg)*	*USEPA IRIS NOAEL (mg/kg)*[2]	*Soil Background Levels (mg/kg)*
Metal HAPS				
Arsenic	0.00004	5.7		11.3
Beryllium	0.00006	1.06		0.56
Cadmium	0.00057	0.00222		0.5
Chromium (Total)	0.01898	0.4		13
Cobalt	0.00003	0.14		8.9
Manganese	0.00000			630
Mercury	0.000004	0.1		0.05
Nickel	0.00094	13.6		13
Selenium	0.000001	27.6		0.37
Organic HAPS				
Formaldehyde	1.05E-05		15	
Methanol	2.38E-04		500	
PAH[1]	1.80E-02	1.52		
Propylene Oxide	4.19E-07		100	

Appendix E

Unitized Annual Average Deposition for HAP Soil Concentration Calculations

Pollutant	Scenario	*Cyv*	*Dywv*	*Dydp*	*Dywp*
		µg-s/g-m3	s/m2-yr	s/m2-yr	s/m2-yr
Inorganic HAPs	Facility	8.52E-02	0.00E+00	1.12E-02	7.91E-03
	Facility + Surrounding Sources	3.30E+02	0.00E+00	7.54E+01	5.46E+00
Organic HAPS	Facility	1.38E+00	0.00E+00	1.93E-01	0.00E+00
	Facility + Surrounding Sources	6.78E+01	0.00E+00	1.08E+01	0.00E+00